6. Introduction

There has been a rise in the trend of multilingual interest over the last few decades observed in the increasing amount of research being published in the topic (Franceschini, 2001). In addition to that fact that it is estimated that up to half the world population may be bi/multilingual (Grosjean, 2010); this proves especially important for a country such as South Africa with its diversity of cultures, ethnicities and also of language. Franceschini (2001) attributes this change in recognition to two primary shifts in orientations. Firstly, a departure from the assumption of homogeneity and a much needed growing sensibility towards diversity. Secondly this is attributed to an ever increasing awareness of a growing migration population and the language variation phenomena that accompanies this geographical flexibility.

Multilingualism has many different definitions and even more practical implications; however for the purpose of this study there is referred to the working definition of multilingualism (Kemp, 2009). This definition is expressed as follows: "Multilingualism conveys the ability of societies, institutions, groups, and individuals to have regular use of more than one language in their everyday lives over space and time". (Franceschini, 2011, p. 346). For the purpose of this study multilingualism will be engaged with as a language experience, which is a subjective experience of multilingualism; assessed in terms of the Language Experience and Proficiency Questionnaire (LEAP-Q).

With the emergence of research in multilingualism also came the investigation of the effects of multilingualism on cognitive functions. During the early years of this research there was actually believed that being multilingual might impair a person's cognitive functioning (Carlson & Meltzoff, 2008); however this notion is contested by the majority modern research which reports the potential advantages (Mueller-Gathercole et al., 2010; Bialystok, 2001; Bialystok, Craik, Green & Gollan, 2009; Zied, 2004; Bialystok, Craik, Klein & Viswanathan, 2004).

Within this scope, the present research will engage with the relationship between language experience of multilinguals and their executive functioning; while throughout acknowledging that bi/multilingualism has both its costs and advantages as set out by amongst others Bialystok and Craik (2010). One such cost is said to be the typical presentation of bi/multilinguals with lower formal language proficiency; for example a smaller vocabulary or weaker access to lexical items. However these bi/multilinguals also seem to possess advantages like enhanced executive control when it comes to non-verbal tasks requiring conflict resolution to name just one (Bialystok & Craik, 2010). Departing from this point, a neuropsychological battery will be employed in order to generate a cognitive profile that will outline the executive functioning of subjects as set out against their self reported language experience.

Alongside the rise in multilingual interest, research on executive functioning has also increased during the twentieth century (Lehto, Juujärvi, Kooistra & Pulkkinen, 2003). Executive functioning is regarded as a component of general cognitive functioning (Bull & Scerif, 2001) and operates by bringing order and control to what would otherwise be an infinitely powerful but uncoordinated piece of mental apparatus (Lezak, 1995). Executive functioning is considered to be a complex cognitive function that incorporates various components and for the purpose of this study the focus will be on: fluency, inhibition, cognitive flexibility and planning (Carlson & Meltzoff, 2008). Part of the increased focus on executive functions research could be postulated to come down to its alleged predictive capacity. Some evidence suggests that throughout development executive functions may actuality be a better predictor of performance that than conventional IQ scores (Diamond &

Lee, 2011). Thus its connotation with the influence of multilingualism on cognition as well (Mueller-Gathercole et al., 2010; Bialystok, 2001; Bialystok et al., 2009; Zied, 2004).

This study will also consider several peripheral and environmental variables in order to evaluate possible relational engagements with executive performance. The variables considered will also come from a demographic questionnaire that will be presented to the participants. Amongst others this will include an account of their schooling history. Education as differential aspect is especially important in light of South Africa's socio-political history and according to authors like Shuttleworth-Edwards (2012) a disparity in the quality of educational systems still remains a prominent consideration. The hope is that by examining the relationship between these variables that underlie self-reported language proficiency and executive functioning ability, new insight will be generated in terms of the field of multilingualism and its applications to the South African context.

7. Theoretical and Conceptual Background

7.1. Literature review

7.1.1. Language Experience

The value of bi/multilingualism in terms of research is something that has been making a more prominent appearance in recent times and in so doing has opened up a new field for investigation and scrutiny of the cognitive abilities (Franceschini, 2001; Gathercole et al., 2010). This is particularly relevant since bi/multilingualism seems to be an ever increasing reality in many countries worldwide (Bailystok et al., 2004). However according to Marian, Blumenfeld and Kaushanskaya (2007) the representation of bi/multilingualism as a separate and distinct entity has lead to gross inconsistencies in many of these research results. According to Bialystok (2001) there is no ‘uncontaminated monolingualism’ to be found in any adult language experience. All languages are exposed to fragments of other languages that embed themselves in its lexicons, be it in the form of popular words or phrases.

However to be considered truly bi/multilingual the notion of proficiency becomes essential (Bialystok, 2001). According to Bialystok (2001), proficiency is an infinitely complex paradigm and could potentially be defined in an endless amount of ways, because to date there are no objective tests or standards for measuring proficiency. Bialystok (1988) also points to the fact that individuals with different levels of bi/multilingualism may aid from these neuropsychological adaptations; like advanced cognitive flexibility, increased inhibitory control and mental switching, to different extents. In past research the use of participants who differ in their bi/multilingual experiences have also proven as limitations for effective comparison and comes primarily down to how bi/multilingualism is operationalised within these studies (Bialystok, 1988; Gathercole et al., 2010). In accordance with the work of Hakuta (1987) the point is raised that even the notion of bi/multilingualism balance of languages is not one that can be taken for granted in research and that instead a continuum of dominance should be the visualised scale for understanding the practical, authentic bi/multilingualism. Thus regardless of the regularity of the use of the different languages within the bi/multi-lingual's arsenal; these bi/multilinguals thus could not be regarded as a homogeneous group (Gathercole et al., 2010). For the purpose of this study a pragmatic definition of proficiency is accepted as set out by Grosjean (1989), stating that multilingualism is denoted by an individual functioning in each given language according to its given needs.

Marian et al. (2007) highlights that the subjective language experience of an individual is significantly impacted by several peripheral characteristics which include; age of language acquisition and history of use. With regards to these determinants it is found that early and intensive exposure to a second language and early mastery of more than one language may be necessary in order to produce real differences in executive functioning (Carlson & Meltzoff, 2008). Thus in order to incorporate these insights, the LEAP-Q was developed (Keating, Van Patten & Jegerski, 2011) and will be used to measure language experience in this research. As stated by Marian et al. (2007) the aim of the LEAP-Q is to overcome these shortcomings and to act as a reliable and valid questionnaire that can be used in the efficient assessment of bi/multilingual' linguistic profiles. Working from this premise we see that according to Hyltenstam and Abrahamsson (2003), much of second language accusation is dependent on the interplay between proficiency and experience variables. When controlled for these variables, there was found that there is a positive relationship between bi/multilingual language experience and optimization of specific areas of cognitive functioning (Carlson & Meltzoff, 2008). Despite the general optimization there are also reported costs of bi/multilingualism including a reduced vocabulary (Portocarrero, Burright

& Donovick, 2007) and increased interference between competing language systems (Gollan, Werner & Montoya, 2002).

7.1.2 Executive Functioning

Numerous authors have attempted their hand at defining executive functions and in summation represent it as a wide-ranging, interlocking collection of functions ascribed with synchronization and organization of mental processes (Pennigton & Ozonoff, 1996; Denckla, 1996; Lezak, 1995). The work of Corbett, Constantine, Hendren, Rockec and Ozonoff, (2009) expands on this notion by stating that: "executive functioning is an overarching term that refers to neuropsychological processes that enable physical, cognitive, and emotional self-control" (p.210). In turn Welsh and Pennington (1988) draw prominence to the fact that executive functions are needed to engage in and sustain effective goal directed behaviour.

The majority of research focusing on executive functioning especially looks at two opposite extremes of the developmental spectrum; either at child development or functioning with regards to advanced age (Bull & Scerif, 2001). Presumably one of the primary reasons for this interest, especially in children, is the fact that executive functioning is a relatively good predictor of performance as touched on above (Bull & Scerif, 2001; Best, Miller, & Naglieri, 2011). Not only is it capable of making predictions regarding positive performance, but executive functioning has also aided us in establishing so called 'executive profiles' for a variety of developmental disorders (Bull & Scerif, 2001).

The primary critique of executive function research thus far is that many of these studies imply a blurred representation of the executive (Miyake et al., 2000). Numerous available articles also speak about executive functioning as a solitary entity; in so doing negating the existence of its numerous subunits and referring to it in abstract terms (Lehto et al., 2003; Ardila, 2008). These kinds of shortcomings neglect the general understanding that the executive functioning system comprises of both core and higher order functions

(Diamond, 2013; Diamond & Lee, 2011). The problem with this is that it overlooks a theoretical engagement with the construct and also how problems within this system may arise and present (Bull & Scerif, 2001). The fact of the matter is that executive functioning is made up of a variety of differential functions, of which the following will be engaged with in this study; mental flexibility, fluency, planning and inhibition (Carlson & Meltzoff, 2008).

Linked to its complex composition it has also been found that executive functions are based on an intimate network of neural connections that stretch throughout the brain and cannot be isolated to a single area; however it is believed that the highest density of this neural network can be located in the frontal lobes (Robinson, Calamia, Gläscher, Bruss & Tranel, 2014; Ardila, 2008). In recognition of the importance of the prefrontal cortex for executive functions it is also needed to distinguish between the dorsolateral prefrontal cortex (dlPFC) and the ventromedial prefrontal cortex (vmPFC). This distinction divides executive abilities into two discrete categories; one for metacognitive and the other for emotional/motivational abilities (Robinson et al., 2014). The dlPFC relates predominantly to metacognitive functions; these consist of conventionally goal directed or organisational behaviour for instance the planning executive function (Robinson et al., 2014; Ardila, 2008). In turn the vmPFC location is associated with the emotional/motivational abilities mentioned above (Robinson et al., 2014).

Previous research studies investigating how the language switching abilities of bi/multilinguals were employed by using brain imaging technology in order to verify these neuro-anatomical regions and found that the regions related to the switching ability are also of utmost importance for general attention and cognitive control (Hedden, & Gabrieli, 2010). Bialystok, Craik and Luk (2012) point out that this overlap in neural sections may be an indicator as just how bi/multilinguals perform better even at non-verbal conflict tests. With regards to the neuro-anatomical discovery of just how the interaction between the executive functioning system and bi/multilingual mind works the theory that is set forth by Bialystok et al. (2012) centers on the plausible premise that somewhat differing neural networks are being employed by bi/multilinguals in comparison to their monolingual counterparts, when it comes to solving nonverbal conflicts. Specifically it is postulated that bi/multilinguals most likely employ a further reaching network. This same theory is fortified in the work of Novick et al. (2005) and Bialystok (2007); here it is seen that bi/multilinguals have the ability to extend brain regions in order to utilise them for functions not traditionally associated with their capacity. This is achieved through intensive practice and the routine use of these neural pathways for the management of competing language systems. One such adapted neural section is Broca’s area, which seems to regularly get used by bi/multilinguals in order to resolve nonverbal conflicts in addition to managing their persistent language conflicts (Novick, Trueswell & Thompson-Schill, 2005; Bialystok, 2007).

When considering sex based differential performance in terms of executive functioning tasks the difference becomes far less apparent than the discussions lobbied thus far. Research has proven inconclusive for the most part on this subject with results varying between no sex-specific differences in performance of executive functioning tasks at all, to only slight variations in the differing results generated between men and women on these executive tasks (Brocki & Bohlin, 2004; Welsh, Pennington & Groisser, 1991). Lezak, Howieson and Loring (2004) present overall results that show minor discrepancies between the performance of men and woman on executive tasks; the woman outperformed men in verbal ability tasks, however men did better than women in visiospatial tasks. However Lezak et al. (2004) also reports on the lack of significant evidence for differential performance between the sexes on any other cognitive tests.

The first component of executive functioning which will be dealt with in this research is fluency. Fluency as a component of executive functioning and its assessments hinge on the executive control mechanism for its goal-directed functioning in organized search (Matute, Rosselli, Ardila & Morales, 2004). Generating information within a specific category means that a host of cognitive skills needs to be employed and that the individual needs to form a self-generated strategy in order to access this information. However, not only does a strategy need to be created to access information, but irrelevant information also needs to be inhibited (Matute et al., 2004). Thus, as a cognitive function, fluency has to recall and use information it has it its disposal, while inhibiting information that will not be seen as useful to the activity at hand.

Fluency can be assessed in two dimensions; the first being verbal fluency and the second non-verbal fluency. For the purpose of this research both these dimensions will be assessed. Verbal fluency will be assessed by the Controlled Oral Word Association Test (COWAT). This neuropsychological measure is commonly used to measure brain function by requiring a participant to generate as many words as they can, based on a prompted phonological cue. This seemingly simple task of retrieval thus requires much more mental exertion on the part of bi/multilinguals in the face of competing linguistic systems (Bialystok, Craik & Luk, 2012). Verbal fluency, as in the case of phonemic fluency, requires efficient verbal retrieval, self-initiation, self-monitoring and inhibition (Batty et al., 2014). According to Bialystok (2009) the exact explanation for the lexical access limitations of bi/multilinguals is still unknown. However one hypothesis that is put forth attributes this weaker retrieval capacity to a lesser accessed neural pathway (Michael & Gollan, 2005). Due to the fact that time is divided between languages the same level of repetition and fortification of retrieval pathways simply cannot be forged as with monolinguals. Thus the lexical access is somewhat less rapid (Michael & Gollan, 2005).

In turn non-verbal fluency, also known as design fluency, will be measured with the Design Fluency Test found in the Delis-Kaplan Executive Function System (D-KEFS). This test aims to investigate: “basic visual attention, motor speed, visual-perceptual skills, and constructional skills” (Swanson, 2005, p. 122). The vast majority of academic information available on design fluency is based on the examination of the neuroanatomic substrates that underpins this executive function and its associated pathology; in so doing it leaves wanting our understanding of it as a neurocognitive construct (Suchy, Kraybill & Larson, 2010; Baldo, Shimamura, Delis, Kramer & Kaplan, 2001). What has been uncovered from these limited investigations into the construct was that non-verbal fluency can be understood as being underpinned by other executive functions; like planning and cognitive flexibility, that get utilized to help operationalize the generation of novel designs (Suchy et al., 2010). Thus although no specific research could be located with regards to bi/multilingualism’s effect on non-verbal fluency, the expectation exists that it would have similar effects as to what we see in terms of the advanced planning and cognitive flexibility effect. For optimal non-verbal fluency individuals also require skills like initiation of problem-solving, creativity, motor planning, inhibition and simultaneous processing of active drawing production and conscious recollections of assessment rules (Swanson, 2005; Suchy et al., 2010). It has also been found that individuals regularly make use of verbal schemes in order to assist in the completion non-verbal tasks. This complicates the task of accurately measuring pure non-verbal fluency without the contamination of verbal intrusion (Evans, Ruff & Gualtieri, 1985).

Mental shifting or cognitive flexibility is another key component of executive functioning that will be explored in-depth in this research. Cognitive flexibility is defined as “the propensity to mentally switch between cognitive strategies in the presence of environmentally changing stimuli” (Figueroa, Youmans & Shaw, 2014, p.955). According to Bialystok (2001), the language systems of bi/multilinguals must be intimately tied to the cognitive control system in ways that are less essential to monolinguals. This is due to the fact that regularly switching between languages and their associated representational systems and avoiding interference from the non-active language subset, is facilitated by the general executive control system (Bialystok et al., 2009).

The Stroop Word Colour Interference Test (SWCIT) is one of the ways in which this cognitive flexibility will be tested, as well as the Trail Making component of the Montreal Cognitive Assessment (MoCA). As a showcase of executive functions interconnected nature it has also been revealed that creativity is intimately connected with cognitive flexibility. This was exhibited by highly flexible individuals rendering more novel concepts in assessments geared towards this function (Figueroa et al., 2014). This then also links to how we find that cognitive flexibility speaks to individuals' ability to revise information and consider obstacles from novel perspectives. As has been discussed at length, research has shown that when controlling for other variables, bi/multilinguals present with an enhanced level of cognitive control; which in this case forms the basis of effective and rapid mental shifting (Bialystok, Craik & Luk, 2012). When using the SWCIT this measured speed of switching is established by the inferred Stroop effect (Mueller-Gathercole et al., 2010). The Stroop effect can be understood as a greater cognitive tax for the inconsonance between written word and colour of ink and a greater Stroop effect is found amongst monolinguals compared to bi/multilinguals (Gathercole et al., 2010).

Relating strongly to the function of cognitive flexibility is the implied second component of the interaction, namely inhibition. MacLeod (2007) takes a prominent stance on the differentiation between neural and cognitive inhibition and how these should not be regarded as the same level of analysis. Executive functions and thus also this study hinge on cognitive inhibition which is defined by MacLeod (2007) as: "the stopping or overriding of a mental process, in whole or in part, with or without intention" (p.5). In terms of all the core executive functions inhibitory control starts showing rudimentary signs of emerging the earliest in the course of individual development with infants exhibiting basic inhibition capacity by the age of six months old (Best & Miller, 2010). Research focusing on metalingustic development in children was, amongst others, used to exemplify the role of inhibition (Bialystok & Craik, 2010). In these experiments children were asked to correct grammatical violations in sentences. Results showed that bi/multilingual children generally preformed much better than monolingual children as soon as these sentences no longer conformed to semantic norms like sentence structure, grammatical rules and logical content expression (Bialystok & Craik, 2010). This exemplifies advanced performance related to an attention advantage in selectivity and inhibition control; rather than metalingustic knowledge (Bialystok & Craik, 2010).

Inhibition is however not a constant or pervasive attribute found equally throughout all bi/multilingual language systems. Rather the notion of differential inhibition is presented by Poarch and van Hell (2012) and suggest that the level of inhibition needed for optimal language balance in the cognition of the bi/multilingual individual will depend on the representation of language systems in their brains. This suggests that it takes more strain and effort to inhibit a language a bi/multilingual is more proficient in and less cognitive energy to suppress a language the individual is less proficient in (Poarch & van Hell, 2012). This adds emphasis to the combination of language systems held by a bi/multilingual individual, as well as to what level they are proficient in each of them.

The final component of executive functioning that pertains to this study is planning. Considerable amounts of literature concerning cognition and neuropsychology has used the notion of planning very loosely. For some researchers planning represents little more than problem solving; whiles others have failed to differentiate between the processing of either constructing and then executing a plan, or alternatively simply following a plan (Hammond, 1990). Technically if this approach is followed every cognitive function involves planning (Goel & Grafman, 1995). This perspective however does hold some fraction of truth. Despite this individual layout of functions it is important to keep in mind that executive functioning components are deeply intertwined and feed into each other's functioning (Ozonoff, Pennington & Rogers, 1991). One example of this interaction is that, in order for effective planning to take place irrelevant information needs to be inhibited (Ozonoff et al., 1991). Goel and Grafman (1995) present planning as a distinct cognitive activity and relate it to design capability. The cognitive function of planning is seen as comparable to complex motor procedures that require a set of individual movements to function as a unitary progression (Grafman et al., 1992). Thus the rationale that underlies planning is that an individual has to have the capacity to look ahead, think in terms of a goal and formulate a plan in their minds before acting on it (Goel & Grafman, 1995). The premise is that planning, like many other executive functions, aid from bi/multilingualism and gets strengthened by the interplay between competing language systems (Bialystok, 2007). Thus the bi/multilinguals would out perform their monolingual counterparts on planning assessments if all other variables were controlled.

7.2. Rationale

A significant amount of work has been done concerning bi/multilingualism and cognitive functioning (Mueller-Gathercole et al., 2010; Bialystok, 2001; Bialystok et al., 2009; Zied, 2004; Bialystok et al., 2004), both with healthy (Bialystok et al., 2004) populations and clinical populations (Diaz & Peraita, 2008). However, the undisputed leader in this multilingual field remains Ellen Bialystok (2001, 2009, 2010) and her work concerning cognitive and linguistic processing. The one consistent current that runs through these studies can be found in their approach to lingualism. Lingualism in this instance referring to the neologism presented by Adamek (2004) that denotes the continuum of language ability via a non-quantifying consideration of language; which exceeds the traditional inclusion of sole proficiency. We find a multitude of definitions for monolinguals, bilinguals and multilinguals within these texts (Franceschini, 2001; Grosjean, 1989; Bialystok, 2001). We even find the defining of types of bilinguals according to their mode of second language acquisition (Bialystok et al., 2009). However all these approaches to lingalism remain static in nature and one is either classified as proficient enough in a language to be considered bilingual or not, in accordance to the guidelines of the study (Bialystok et al., 2009).

Taking this into consideration, this study presents a different view of lingualism. Instead of ridged criteria to either include or exclude someone from multilingualism at face value; this research proposes a continuum of language experience. Here an individual can be located on a continuum between monolingual and multilingual based on their own language experience (LEAP-Q). This is especially relevant to the South African context where people often are proficient in quite a number of languages, however to differential degrees and are also exposed to these languages on a regular basis (StatsSA, 2012). This is also taking into consideration the country’s socio-political history and discriminatory practices between language preferences and the legacy that has left in its wake (Alexander, 2012). Thus this research aims to investigate at the relationship between these language experiences and executive functioning of the individuals who embody them. A study of this kind in this milieu would generate valuable insights into the field and also shed light on some of the peripheral variables. The education system in particular could be positively influenced with added insight into language of instruction and in how to navigate multilingualism.

7.3. Research Question

Leading on from the discussion above, this research would like to pose the following research question: ‘Is there any relationship between the language experience of multilinguals, as accounted for by self reported proficiency and the executive functioning’.

8. Method

8.1 Research Aims

8.1.1 General Aims

- To explore the relationship between self reported language experience and executive functioning on a group of South African Multilinguals (who report to be fluent in more than 2 languages).

8.1.2 Specific Aims

- To explore possible links between level of education and executive functions.
- To explore possible links between language dominance and executive functions.
- To explore the relationship between preference of reading language and executive functions.
- To explore the relationship between percentages of time exposed to differential languages and executive functions.
- To examine the influence of language experience on each of the differential components of executive functioning; including mental flexibility, inhibition and fluency.

8.2. Research Design

8.2.1 Research Variables

8.2.1.1 Language Experience

8.2.1.1.1 Conceptual Definition

Language experience can be conceptualized in many different forms, as well as employed operationally in a variety of ways (Vaid, 1983). One such dimension that is regularly employed pertains to the number of language systems a person is fluent in (Eviatar, 1997). This implied multilingualism is defined by Franceschini (2001) as “the ability of societies, institutions, groups, and individuals to have regular use of more than one language in their everyday lives over space and time” (p. 346). Another dimension used to conceptualize language experience can be represented by the characteristics of language that we are able to formally tests, for example preferences in reading or writing (Eviatar, 1997).

8.2.1.1.2 Operational Definition

For the purpose of this study language experience was assed using the Language Experience and Proficiency Questioner (LEAP-Q). This assessment takes into consideration the spectrum of languages the participant is fluent in and relates it to their differential experiences of each language. Additionally both self report language proficiency and language history variables were measured in order to encapsulate the multilingual criteria (Maria et al., 2007). A multilingual criterion was met if a participant is proficient in at least three languages. The combination of languages is irrelevant, as long as all the languages are represented in the eleven official languages of South Africa. The individual also needs to be exposed to regular contact with all the languages.

8.2.1.2 Executive functioning

8.2.1.2.1 Conceptual Definition

Executive functioning is a component of general cognitive functioning and is seen as a relatively good predictor of performance (Bull & Scerif, 2001). Executive functioning is generally understood to be an extensive, interlocking group of functions and despite its different components, the prefrontal cortex is said to be the most important area of functioning for this cognitive component (Ardila, 2008). Lezak (1982) defines executive functioning as: “those mental capacities necessary for formulating goals, planning how to achieve them, and carrying out the plans effectively" (p.281). Functions of 'executive behavior' include amongst others planning, control, monitoring and inhibition (Rabbitt, 1997).

8.2.1.2.2 Operational Definition

For the purpose of this research each component of executive functioning was understood in terms of the data that was be rendered by the neuropsychological assessments assigned to testing for it:

- Fluency is understood in terms of verbal and nonverbal fluency. Here verbal fluency was assessed with the use of raw scores from the Controlled Oral Word Association Test (COWAT). Nonverbal fluency was tested for using the Delis-Kaplan Executive Function System (D-KEFS) - Design Fluency Test.
- Cognitive flexibility will be assessed using the Trail Making exercise from the MoCA, as well as the Stroop Word Colour Interference Test (SWCIT).
- Inhibition in turn will also be addressed using the SWCIT according to Van der Elst, Van Boxtel, Van Breukelen, and Jolles (2006); as well as the Design Fluency Test from the D-KEFS.
- Planning will be assessed using the Clock Drawing test form the MoCA and the Design Fluency Test from the D-KEFS.

8.2.2 Research Design

This research design is grounded in a positivist research paradigm. Data acquisition took the shape of a non-experimental, cross-sectional design (Bhattacherjee, 2012). The research examines the relationship between language experience and executive functioning by making use of a single sample of participants that are assessed during a once off engagement.

8.3 Sample and Sampling

For the purpose of this research a homogeneous participant sample was generated through non-probability, convenience sampling (Bhattacherjee, 2012). Participants were selected according to the inclusion criteria, which includes being between 18 and 25 years old, having completed secondary education and holding a valid matric certificate. The reasoning behind this specific age bracket is that the majority of South African's complete grade twelve by the age of 18; thus accommodating the inclusionary criterion that stipulates participants need to hold a valid matric certificate. The upper limit was decided in order to control for the changes in the South African educational system that was implemented in 2008. Participants will therefore only come from the population that graduated after 2007 and will thus be under the age of 25.

As based on the core of this research, each participant was multilingual. As defined per the operational definition, this implies that the participant is fluent in at least three languages. English also had to have been the participant's language of instruction at high school level. This assumes that the participant has at least five years of schooling experience in English and afforded for enough proficiency. This English proficiency is needed since the assessments were conducted in English and this also met the language requirements of the researchers that conducted the testing. The home language of the participant and any other additional languages beyond English could have been any combination of South Africa's eleven official languages. The only other criterion was that the participant has to engage with these reported languages on a regular basis. The age of language acquisition is relevant but will not be controlled for.

Participants were excluded if they do not meet the inclusionary criterion or alternatively if they suffer from any physical or mental health conditions that may influence the Central Nervous System. This construct of health was established by the current absence of the following: metabolic conditions, psychiatric conditions, immunological conditions and neurological conditions. In order to be classified as a healthy adult for the purpose of this study the participant also had to have never sustained a concussion (defined by either the loss of consciousness or hospitalization) or traumatic brain injury. The use of medication was enquired about and individual based decisions were made if needed. Due to the nature of the sample there was also enquired about recreational drug use in the demographic questionnaire. Any potential participant that had engaged with these substances (either drugs or heavy drinking) on a regular basis or had used in the last 4 weeks before testing was not included. These criterions were included due to the fact that this research is reliant on a healthy adult sample and the possibility of illness affecting the results (Freitas, Simoes, Alves, & Santana, 2012). After offering individuals that meet the criteria the opportunity to take part in the research, a sample of 30 participants was generated.

8.4 Instruments

8.4.1. Demographic Questionnaire:

The Demographic Questionnaire is essential to this research in order to account for differential variables in the South African context that may influence results. As seen in Appendix A, this questionnaire acts as to record: the participant's age, gender, occupation and schooling. The schooling history was differentiate between public and private school, a rural or urban location and also the language of instruction. According to Shuttleworth-Jordan (1996) education has a differentiated impact on South Africans based not only on their level of education, but also on quality; thus this notion was taken into consideration in the way of information collection.

8.4.2. Language Experience and Proficiency Questionnaire (LEAP-Q):

The LEAP-Q was developed by Maria, Blumenfeld and Kaushanskaya (Keating et al., 2011). The LEAP-Q investigates self-reported proficiency in terms of three language requirements, namely; reading, understanding and speaking. These attributes are then scored on a continuum between 1 and 10 in order to represent proficiency. As elaborated on above, the instrument also considers more abstract areas of engagement with language on a day to day basis. These activities of engagement may include for example the proportion of time watching TV or conversing, in each of the languages (Keating et al., 2011). Maria et al. (2007) state that the overarching aim of the LEAP-Q is to function as a reliable and valid questionnaire that can be used in the efficient assessment of bilinguals' linguistic profiles.

The LEAP-Q can be employed to asses language experience in both bilinguals and multilinguals of all types and does not discriminate against age of acquisition, proficiency of acquisition or balance between acquired languages (Maria et al., 2007). The questionnaire is intended for healthy adults and the participant requires high school level literacy, especially since this is a self reported instrument. The assessment is suited for any ethnic, cultural or linguistic background (Maria et al., 2007). It is approximated that the average bilingual can complete the questioner in roughly 15 minutes (Maria et al., 2007). The internal validity of the LEAP-Q was examined using factor analysis and multiple regression analyses; the criterion-based validity was also examined using multiple regression and correlation analyses against a battery of standardized behavioural measures. This self-report assessment was found to be a reliable index of language proficiency through strong correlations with objective standardized proficiency measures. Ultimately the LEAP-Q was found to be an effective, efficient, valid, and reliable tool for assessing bilingual language status (Maria et al., 2007). Spesific information on the use of the LEAP-Q in the South African setting was unavailable at the time of this research. Extensive searches were employed into numerous databases; like Science Direct, Taylor and Francis, PubMed, PsychArticles and PsychInfo to name just a few. Seach words included; Language Experience and Proficiency Questionnaire, LEAP-Q, South Africa, Africa, Cockcroft, K, Language Proficiency and South African Language Experience.

8.4.3. Montreal Cognitive Assessment (MoCA):

According to Freitas et al. (2012) the MoCA, was specifically developed to screen for milder forms of cognitive impairment. However for the purpose of this research select items from the MoCA were used orientated to assessing specific functions that are considered to be part of the executive functioning realm. In this case that would be the Clock Drawing and Trail Making exercises.

The test takes the format of a single page assessment that was completed in part by the participant and in part by the administrator. The assessment runs approximately 10 to 15 minutes. Ultimately the assessment is scored out of 30 and the higher a participants score the better cognitive performance is indicated a score of 26 or more would be considered normal for a healthy adult (Nasreddine et al., 2005). The functions used to asses executive functioning were the adapted Trail Making test, in order to test mental flexibility and the Clock Drawing test in order to asses planning (Valley, 2011). The MoCA has been found to have a good test-retest reliability, inter-rater reliability, and convergent validity; the internal reliability was found to be .78 (Hoops et al., 2009; Toglia, 2011).

8.4.4. Controlled Oral Word Association Test (COWAT):

COWAT is a neurocognitive ability test and has been widely used for detection of verbal communication deficits (Loonstra, Tarlow & Sellers, 2001). In the context of this research the COWAT was employed for assessment of verbal fluency. The participant were given 60 seconds and asked to produce as many words as possible relating to the prompt given by the researcher. In this case the test was based on phonemic categories and the participant were given the letters F, A and S, each in turn (Batty et al., 2014).

The inter-rater reliability for the COWAT is excellent with scores ranging between .8 and .9; so was the test-retest reliability was .84 (Ross et al., 2007). Face validity and consistent reliability are both positive attributes of the COWAT. Norms for the measure were established for various ages, ranging all the way from very young to very old, differential levels of education, ethnicities and geographic diversity. However it should be noted that it was shown that a higher level of education tended to result in a generally higher score, thus this should be taken into consideration when interpreting this research data (Ruff, Light, Parker, & Levin, 1996).

8.4.5. Delis-Kaplan Executive Function System (D-KEFS) - Design Fluency Test:

D-KEFS is an executive functioning assessment tool that is widely used in both research and clinical settings. The standardized tool can be administered to both children and adults between the ages of 8 and 89 (Homack et al., 2007). This tool allows for useful insights into frontal lobe functioning. These functions include problem solving, inhibition, impulse control, abstract thinking, flexibility of thinking, planning and creativity (Homack et al., 2007). The D-KEFS is composed of nine stand-alone tests, of which this study utilized the Design Fluency Test for research purposes (Homack et al., 2007).

In the Design Fluency Test the participant is given 60 seconds to generate as many unique designs as they can within the given guidelines. The test consists of three conditions, each requiring a different set of instructions; however that all rely on the same premise. The participant is asked to connect an array of dots using four straight lines that will then create a design. This design he/she creates needs to be different each time. In the second and third condition some of the dots are filled and some are empty. Working from this arrangement participants are then asked to create their designs by connecting just empty dots in the second condition and to alternate between filled and empty dots in the third condition (PsychCorp, 2001).

The D-KEFS was standardized in accordance with the 2000 U.S. census and using an all U.S. citizen sample (Swanson, 2005). This implies that caution will be used when interpreting data that will now be generated from my South African population. D-KEFS shows a moderately good internal consistency and good test-retest reliability (Swanson, 2005). Validity has been demonstrated for D-KEFS by various studies, these studies include inter-correlations of measures within individual D-KEFS tests and correlations between measures of different D-KEFS tests. Also studies showing the correlations of D-KEFS with other cognitive tests including the California Verbal Learning Test (second edition) and the Wisconsin Card Sorting Test (Delis, Kaplan & Kramer, 2001).

8.4.6. Stroop Word Colour Interference Test (SWCIT):

The Golden and Freshwater (1998) version of the Stroop Colour and Word Test will be utilized in this research. This version of the Stroop is made up of three trials and allows participants 45 seconds to answer. First a participant is expected to read the names of colours, printed in black ink. In the second trail the participant is requested to report the different colours of ink rows of “X’s” are printed in. For the final trial the participant has to name the colour words that are printed on the page, however these words are printed in different colours (Golden & Golden, 2002). The paradigm of the test is based on the central comparison between an individual's performance on a basic task, in contrast to their performance on an analogous task in which automatic, habitual response need to be suppressed. In this test, the basic task takes the shape of reading names of colours, whereas the analogous task sees these printed names of colours now being printed in incongruent ink colours to the written word. This different time score between the two activities is known as "the Stroop interference effect" (Van der Elst et al., 2006).

This "Stroop interference effect" as referred to by Van der Elst et al., (2006) was seen as acting as a measure for executive functioning in this research. Specifically it tested cognitive flexibility and control (Strauss, Sherman & Spreen, 2006; Moore & Malinowski, 2009). It has however been found that demographic variables considerably influence the SWCIT scored. Thus caution has to be instated when analysing data in the South African context. With this said; Van der Elst et al. (2006) reports that the test-retest reliability for the SWCIT is significant. It was concluded that the word trail coefficient is .83; the colour trail coefficient is .74 and finally the word-colour trail coefficient .67. Construct validity for SWCIT was tested for with interference scores. These scores correlated well with measures of attention and response inhibition (May and Hasler, 1998).

8.5. Procedure

This research project was executed as part of a larger research study that focuses on the relationship between multilingualism and cognitive functioning. The test battery as set out below encapsulates the battery of assessments used for the larger study as a whole. From which this research will only be utilizing the assessments as set out in the 'Instrument' section. The assessments not discussed here, namely the Rey Auditory Verbal Learning Test (RAVLT), Visual Reproduction (WMS-IV) and Letter-Number Sequencing (LNS) were utilized by another researcher. Descriptions of these measures have been included as

Appendix D. The proposed assessments for this research endeavour were thus selected ad hoc and will be used to generate the most theoretically consistent results from the set.

Following successful obtainment of ethical clearance from the Humanities Ethics Committee at the University of the Witwatersrand, data collection commenced. Data collection was executed by myself and another researcher, Otsile Motlhabane. Both being M.A. Research Psychology students currently enrolled at the University of the Witwatersrand. The sample of thirty participants was split in two and subsequently each of the researchers conduct a total of fifteen assessments; after which the data was pooled. Each battery of protocols were scored by both researchers in order to increase accuracy of scores. The assessments were conducted at a location that was best suited for the participant and that also allows for adequate testing conditions required by the instruments, for example a seminar room in the psychology department.

After going through the ethical outlines with the participant and obtaining their consent, the assessment battery commenced. The full research battery took roughly 60 minutes to complete and was executed in the following order of measures:

1. Demographic Questionnaire
2. Language Experience and Proficiency Questioner (LEAP-Q)
3. Montreal Cognitive Assessment (MoCA)
4. Rey Auditory Verbal Learning Test (RAVLT) Trail I to VI
5. Visual Reproduction (WMS-IV) Trail I and II
6. Letter-Number Sequencing (LNS)
7. Delis-Kaplan Executive Function System (D-KEFS) Design Fluency Test
8. Controlled Oral Word Association Test (COWAT)
9. Golden and Freshwater Stroop Word Colour Interference Test (SWCIT)
10. Rey Auditory Verbal Learning Test (RAVLT) Delayed recall and Recognition

11. WMS-IV Delayed recall and Recognition

8.6. Ethical Consideration

This research was conducted with a healthy adult population. Thus ethical clearance was applied for from the Humanities Ethics Committee at the University of the Witwatersrand and obtained. The central ethical concern was for that of human dignity and rights to be maintained at all times. Smith (2003) emphasizes the principal of obtaining informed consent from all participants. This was done in the form of consent forms (Appendix C) signed off on by all the participants. The consent form (Appendix C) was also be accompanied by a Participant Information sheet (Appendix B) that was be kept by the participants. Working from the participant information sheets (Appendix B) participants were thoroughly briefed on both the aim and content of the study; as well as a clear stipulation of the role of the participant. No misleading was employed and no activities outside the stipulation of the consent forms were entered into. In so doing these attributes met the full disclosure principal of ethics (Smith, 2003). According to Smith (2003), this ensured that all participants were taking part in the study completely out of free will and are also fully aware of the implied risks and benefits associated with the participation.

The principal of do no harm was honoured by conducting research that poses minimal risk to potential participants (Lichtman, 2013). No risks to participants in this study were anticipated. However, the cognitive testing may have elicited mild anxiety or irritation if some tasks were perceived as difficult. If this was the case the participant would have been offered the option to pause the session before continuing. They may also have refrained from answering any particular question with no negative consequences as pointed out in the participant information sheet (Appendix B). Participants were reminded that their participation was voluntary and they were never forced to partake in any activity that could make them uncomfortable or that would endanger them in any way. Participants were also made aware of the fact that they could opt out of the research at any time without any repercussions. This met the stipulations of providing the right to withdraw. In turn it was also communicated to participants that they would not receive any direct benefits from this study, whether it was compensatory, monitory or otherwise.

Data collection was conducted by myself and another researcher, Otsile Motlhabane; both registered students at The University of the Witwatersrand, enrolled for M.A. Research Psychology degrees. Both researchers were trained in the administration of these neuropsychological tests and worked under the supervision of Ms. Aline Ferreira-Correia who is a registered Clinical Psychologist. It should be noted that the administration of these tests were purely for research purposes and at no point where they used for clinical purposes.

According to Smith (2003), the principal of protecting anonymity and confidentiality is essential to a research endeavor. Any and all information shared by the participants was and continues to be treated with the utmost care. The only time anonymity could not be absolutely accounted for was during the face to face assessments, where researchers were aware of the participant’s identity. However no names or identities were coupled to responses during the assessment. Instead each participant received a serial number that was be used throughout the process. Researchers’ maintained professionalism at all times as far as the disclosure of information is concerned. Results were only discussed with other members of the research team. Results and data are also kept in the supervisor’s office where it can only be accessed by the research team.

Lastly Lichtman (2013) touches on this subject of giving back to research participants. Due to the fact that no identities were recorded during data collection, individual feedback is not possible. However a one page summary of research findings was drafted and made available to participants after the completion of the research reports. The full M.A. research reports resulting from this research is however also available in the library of the University of the Witwatersrand, which offers access to material on the world-wide web.

9. Results

Results were obtained by capturing scored test results into Microsoft Excel for sorting and exported to the computer-based statistical analysis program SPSS, which was used to run the statistical analysis. This chapter will firstly present the demographic information for the sample; including frequencies and percentages for sex, age categories, level of education. As well as a table consisting of language information made up of the frequencies and percentages for number of languages known, number of languages of instruction and the top three dominant languages; as well as mean, minimum and maximum results for applicable measurements.

The descriptive statistics obtained for the executive functioning scales are presented showcasing the exploration of skewness. Following is the results obtained from performing a multiple regressions using the independent variables of language experience in relation to the dependant variable which represents different components of executive functioning will be showcased. These will be presented in terms of the neuropsychological scale that was used; each scale can be made up of either different composites of results or different subsets. This layout was selected instead of a presentation per executive component being investigated since many tests function as representations of more than one executive function component. Finally the section will be brought to a close with the presentation of residual statistics; also offered in terms of the neuropsychological scale.

Table 9.1

Frequency table for demographic information

Variable	N = 30	Frequency	Percentage
Gender			
Female	18	18	60
Male	12	12	40
Age Categories			
18-20	7	7	23.3
21-23	11	11	36.7
24-25	12	12	40
Highest Level of Education			
Matric (12yrs)	9	9	30
Degree/ Diploma (15yrs)	9	9	30
Honours Degree (16yrs)	12	12	40

Table 4.1 presents the demographic information for the sample with regards to gender, age categories and highest level of education. Here it was found that the sample is predominantly female and that it is also representative of predominantly individuals age 21 and over. Table 4.1 also indicates a homogenous distribution between level of education, with only slightly more participants holding an honours degree.

Table 9.2

Descriptive statistics for language information

Variable	N = 30	Frequency	Percentage	Mean	Min	Max
Number of Languages Known				4.37	3	9
3	8	8	26.7			
4	11	11	36.7			
5	7	7	23.3			
6	2	2	6.7			
7	1	1	3.3			
9	1	1	3.3			
Number of Languages of Instruction				1.33	1	3
1	21	21	70			
2	8	8	26.7			
3	1	1	3.3			

(continued)

Table 9.2

Descriptive statistics for language information (Continued)

Variable	N = 30	Frequency	Percentage	Mean	Min	Max
Dominant Language 1						
Sotho	10	10	33.3			
Sepedi	1	1	3.3			
Tswana	4	4	13.3			
Xhosa	1	1	3.3			
Zulu	4	4	13.3			
Tsonga	1	1	3.3			
English	9	9	30			
Dominant Language 2						
Sotho	3	3	10			
Sepedi	2	2	6.7			
Tswana	3	3	10			
Venda	1	1	3.3			
Xhosa	1	1	3.3			
Zulu	5	5	16.7			
English	14	14	46.7			
Afrikaans	1	1	3.3			
Dominant Language 3						
Sotho	6	6	20			
Sepedi	2	2	6.7			
Tswana	2	2	6.7			
Venda	1	1	3.3			
Zulu	12	12	40			
English	6	6	20			
Afrikaans	1	1	3.3			

Table 9.2 presents the descriptive statistics for language information and indicates that the highest percentage of participants knew four languages. Most participants only received formal instruction in one language in this sample. With regards to dominant languages Table 9.2 indicates that Sotho is the most prominent first dominant language, followed closely by English. English was unquestionably the most prominent second dominant language and for the third dominant language Zulu proved to be the most important.

Descriptive statistics will now be presented for dependant variables in Table 9.3. This includes standard deviation, mean and skewness coefficients generated for this studies neuropsychological battery comprising of the MoCA: Clock Drawing and Trail Making, D-KEFS: Design Fluency, COWAT and SWCIT

Table 9.3

Descriptive Statistics for Executive functioning scales

Scale	N = 30	Minimum	Maximum	Mean	Std. Deviation	Skewness
MoCA						
Trail Making	30	0	1	.97	.183	**-5.477**
Clock Drawing	30	1	3	2.40	.770	-.854
D-KEFS: Design Fluency						
Condition1	30	4	12	7.73	2.243	.181
Condition 1 Total Errors	30	0	4	1.30	1.236	1.024
Condition 2	30	4	14	8.93	2.753	-.117
Condition 2 Total Errors	30	0	8	2.10	2.090	**1.242**
Condition 3	30	1	11	6.00	2.150	.089
Condition 3 Total Errors	30	0	15	3.00	3.206	**2.376**
Total Set Loss	30	0	17	3.87	3.627	**1.937**
Total Repetition	30	0	10	2.53	2.700	**1.413**
Design Accuracy	30	51	100	78.90	12.090	-.072
COWAT						
FAS Total	30	21	56	37.73	9.555	.134
FAS Total Errors	30	0	24	1.83	4.316	**4.975**
SWCIT						
Word	30	29	124	89.23	19.403	**-1.652**
Colour	30	41	95	59.37	17.744	-.885
Colour-Word	30	15	106	38.13	14.832	**3.371**

In accordance with Table 9.3 the skewness coefficients fell slightly outside the desired parameters for what would be considered normal distribution and thus the deduction can be made that the criterion for normality was not met by the sample in question. This was taken into account and thus Multiple Regression was selected for further analysis since it is robust enough to stand up against a slightly skewed sample (Osborne, & Waters, 2002).

The first multiple regression represented is that of the MoCA: Clock Drawing and Trail Making; it is reflected by a model summary, ANOVA table and finally a coefficients table.

Table 9.4

Model Summary of the MoCA scale: Trail Making and Clock Drawing

					Change Statistics				
Model	R	R^2	Adjusted R^2	Std. Error of Estimate	R Square Change	F Change	df1	df2	Sig. F Change
Trail making	.737[a]	.543	-.104	.192	.543	.839	17	12	.639
Clock drawing	.774[a]	.598	.030	.759	.598	1.052	17	12	.475

Table 9.5

ANOVA of the MoCA scale:Trail Making and Clock Drawing

Model	Sum of Squares	df	Mean Square	F	Sig.
Trail making					
Regression	.525	17	.031	.839	.639[b]
Residual	.442	12	.037		
Total	.967	29			
Clock drawing					
Regression	10.294	17	.606	1.052	.475[b]
Residual	6.906	12	.575		
Total	17.200	29			

Table 9.6

Coefficients of the MoCA scale: Trail Making and Clock Drawing

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Trail marking							
(Constant)	.712	1.784		.399	.697		
Number of languages known	.005	.059	.036	.081	.936	.200	5.007

(continued)

Table 9.6

Coefficients of the MoCA scale: Trail Making and Clock Drawing (Continued)

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Number of languages of Instruction	.034	.098	.101	.345	.736	.441	2.265
% Time exposed to Lang	-6.142E-5	.004	-.004	-.014	.989	.584	1.713
% Time exposed to Lang	.000	.005	-.013	-.041	.968	.347	2.880
% Time exposed to Lang	-.009	.005	-.564	-1.768	.102	.374	2.675
Exp Lang 5 or more % of time	.010	.020	.299	.481	.639	.099	10.118
Chose to Read Lang1 % of time	-.003	.016	-.404	-.179	.861	.007	133.478
Chose to Read Lang2 % of time	-.002	.018	-.108	-.087	.932	.025	40.295
Chose to Read Lang3 % of time	-.002	.019	-.237	-.122	.905	.010	98.901
Chose to Read Lang4 % of time	.007	.020	.371	.362	.724	.036	27.626
Chose to Read Lang5 % of time	-.016	.025	-.301	-.615	.550	.159	6.293
Gender	.074	.111	.203	.667	.517	.412	2.426
Highest Education level	.009	.085	.043	.109	.915	.244	4.106
Age Category	.025	.080	.110	.318	.756	.319	3.135
Dominant Language 1	.017	.018	.285	.979	.347	.451	2.216
Dominant Language 2	.047	.025	.678	1.905	.081	.301	3.326
Dominant Language 3	-.008	.024	-.122	-.355	.729	.323	3.093
Clock drawing							
(Constant)	-5.352	7.053		-.759	.463		
Number of languages known	-.354	.233	-.622	-1.519	.155	.200	5.007
Number of languages of Instruction	-.676	.388	-.480	-1.742	.107	.441	2.265
% Time exposed to Lang	-.003	.017	-.048	-.200	.845	.584	1.713
% Time exposed to Lang	-.006	.019	-.098	-.317	.757	.347	2.880
% Time exposed to Lang	-.002	.020	-.024	-.079	.938	.374	2.675
Exp Lang 5 or more % of time	-.002	.078	-.013	-.022	.982	.099	10.118
Chose to Read Lang1 % of time	.099	.065	3.212	1.520	.154	.007	133.478

(continued)

Table 9.6

Coefficients of the MoCA scale: Trail Making and Clock Drawing (Continued)

Model	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Chose to Read Lang2 % of time	.099	.072	1.598	1.377	.194	.025	40.295
Chose to Read Lang3 % of time	.133	.074	3.276	1.801	.097	.010	98.901
Chose to Read Lang4 % of time	.088	.078	1.080	1.123	.283	.036	27.626
Chose to Read Lang5 % Time of time	.047	.100	.213	.464	.651	.159	6.293
Sex	.134	.440	.086	.303	.767	.412	2.426
Highest Education level	-.118	.338	-.129	-.348	.734	.244	4.106
Age Category	.129	.315	.133	.410	.689	.319	3.135
Dominant Language 1	-.013	.070	-.049	-.182	.859	.451	2.216
Dominant Language 2	.019	.097	.066	.198	.846	.301	3.326
Dominant Language 3	-.010	.093	-.035	-.110	.914	.323	3.093

The multiple regression conducted to predict the Trail Making subset of the MoCA scale is represented in Table 9.4, 9.5 and 9.6 based on number of languages known, number of languages of instruction, the percentage of time exposed to each language, percentage of time chosen to read in each language, gender, highest education level, age category and the top three dominant languages. Table 9.5 shows that a significant regression equation was not found since ($F(17,12) = .839$, $p < .639$). From Table 9.4 the R^2 score can be denoted as .543 and R as .737. From Table 9.6 it can be seen that none of the independent variables investigated generated a significant score. In turn when considering the MoCA Clock Drawing test; Table 9.4, 9.5 and 9.6 also represent the multiple regression for this test based on number of languages known, number of languages of instruction, the percentage of time exposed to each language, percentage of time chosen to read in each language, gender, highest education level, age category and the top three dominant languages. Table 9.5 also shows that significant regression equation cannot be found for this measure with (F(17,12) = 1.052, p < .475). For the clock drawing test Table 9.4 indicates a R score of .774 and a R^2 score of .598. Table 9.6 however shows that this measure also has no significantly contributing independent variables.

Table 9.7

Model Summary of the COWAT scale

					Change Statistics				
Model	R	R^2	Adjusted R^2	Std. Error of Estimate	R Square Change	F Change	df1	df2	Sig. F Change
FAS Total	.897[a]	.804	.526	6.579	.804	2.893	17	12	.033
FAS Total Errors	.709[a]	.503	-.200	4.729	.503	.715	17	12	.743

Table 9.8

ANOVA of the COWAT scale

Model	Sum of Squares	df	Mean Square	F	Sig.
FAS Total					
Regression	2128.501	17	125.206	2.893	.033[b]
Residual	519.365	12	43.280		
Total	2647.867	29			
FAS Total Errors					
Regression	271.839	17	15.991	.715	.743[b]
Residual	268.328	12	22.361		
Total	540.167	29			

Table 9.9

Coefficients of the COWAT scale

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
FAS Total							
(Constant)	124.879	61.165		2.042	.064		
Number of languages known	2.931	2.023	.415	1.449	.173	.200	5.007
Number of languages of Instruction	1.208	3.364	.069	.359	.726	.441	2.265
% Time exposed to Lang	-.385	.148	-.437	-2.609	.023	.584	1.713
% Time exposed to Lang	.113	.161	.151	.698	.498	.347	2.880
% Time exposed to Lang	-.362	.169	-.448	-2.142	.053	.374	2.675
Exp Lang 5 or more % of time	-.074	.680	-.044	-.109	.915	.099	10.118
Chose to Read Lang1 % of time	-1.204	.566	-3.144	-2.129	.055	.007	133.478
Chose to Read Lang2 % of time	-1.413	.627	-1.830	-2.255	.044	.025	40.295
Chose to Read Lang3 % of time	-1.360	.638	-2.710	-2.131	.054	.010	98.901
Chose to Read Lang4 % of time	-.857	.681	-.846	-1.258	.232	.036	27.626
Chose to Read Lang5 % of time	-2.260	.871	-.832	-2.594	.024	.159	6.293
Gender	5.746	3.819	.300	1.505	.158	.412	2.426
Highest Education level	-3.940	2.930	-.348	-1.345	.204	.244	4.106
Age Category	8.272	2.733	.685	3.027	.011	.319	3.135
Dominant Language 1	1.788	.604	.564	2.962	.012	.451	2.216
Dominant Language 2	1.545	.841	.428	1.837	.091	.301	3.326
Dominant Language 3	.098	.808	.027	.121	.905	.323	3.093
FAS Total Errors							
(Constant)	43.031	43.964		.979	.347		
Number of languages known	-.677	1.454	-.212	-.465	.650	.200	5.007
Number of languages of Instruction	-.427	2.418	-.054	-.177	.863	.441	2.265
% Time exposed to Lang	-.225	.106	-.564	-2.117	.056	.584	1.713
% Time exposed to Lang	.064	.116	.190	.552	.591	.347	2.880
% Time exposed to Lang	-.201	.122	-.549	-1.650	.125	.374	2.675
Exp Lang 5 or more % of time	.101	.489	.134	.207	.839	.099	10.118
Chose to Read Lang1 % of time	-.199	.407	-1.150	-.489	.633	.007	133.478

(continued)

Table 9.9
Coefficients of the COWAT scale (Continued)

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Chose to Read Lang2 % of time	-.281	.450	-.807			.025	40.295
Chose to Read Lang3 % of time	-.256	.459	-1.128	-.557	.587	.010	98.901
Chose to Read Lang4 % of time	-.280	.489	-.611	-.571	.578	.036	27.626
Chose to Read Lang5 % of time	.237	.626	.193	.379	.712	.159	6.293
Gender	1.052	2.745	.121	.383	.708	.412	2.426
Highest Education level	-.452	2.106	-.089	-.215	.834	.244	4.106
Age Category	-1.858	1.964	-.341	-.946	.363	.319	3.135
Dominant Language 1	.106	.434	.074	.245	.810	.451	2.216
Dominant Language 2	-.704	.605	-.432	-1.164	.267	.301	3.326
Dominant Language 3	-.528	.581	-.325	-.909	.381	.323	3.093

Table 9.7, 9.8 and 9.9 represent the multiple regression conducted for the COWAT scale based on number of languages known, number of languages of instruction, the percentage of time exposed to each language, percentage of time chosen to read in each language, gender, highest education level, age category and the top three dominant languages. This scale has two scores that are of importance for interpretation; firstly the FAS total and secondly the FAS Total Errors.

According to Table 9.8 a significant regression equation was found for the FAS Total consisting of ($F(17,12) = 2.893$, $p < .033$); however one could not be found for FAS Total Errors since ($F(17,12) = .715$, $p < .743$). Table 9.7 indicates an R^2 score for FAS Total as .804 and for FAS Total Errors as .503; in turn the R scores are .897 for FAS Total and .709 for FAS Total Errors. Lastly it is noted that according to Table 9.9, percentage of time exposed to language 1 and 3, percentage of time chosen to read in language 1, 2, 3 and 5, age category and dominant language 1, were all significant predictors of FAS Total.

Table 9.10

Model Summary of the SWCIT scale

					Change Statistics				
Model	R	R^2	Adjusted R^2	Std. Error of Estimate	R Square Change	F Change	df1	df2	Sig. F Change
Word	.696[a]	.485	-.245	21.646	.485	.665	17	12	.785
Colour	.908[a]	.824	.574	11.585	.824	3.296	17	12	.020
Word-Colour	.736[a]	.542	-.106	15.601	.542	.836	17	12	.642

Table 9.11

ANOVA of the SWCIT scale

Model	Sum of Squares	df	Mean Square	F	Sig.
Word					
Regression	5294.721	17	311.454	.665	.785[b]
Residual	5622.646	12	468.554		
Total	10917.367	29			
Colour					
Regression	7520.430	17	442.378	3.296	.020[b]
Residual	1610.537	12	134.211		
Total	9130.967	29			
Word-Colour					
Regression	3458.872	17	203.463	.836	.642[b]
Residual	2920.594	12	243.383		
Total	6379.467	29			

Table 9.10, 9.11 and 9.12 represent the multiple regression conducted for the SWCIT scale based on number of languages known, number of languages of instruction, the percentage of time exposed to each language, percentage of time chosen to read in each language, sex, highest education level, age category and the top three dominant languages. This scale has three scores that are of importance for interpretation; a Word score, a Colour score and finally a Word-Colour score.

Table 9.12

Coefficients of the SWCIT scale

Model	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Word							
(Constant)	-128.135	201.251		-.637	.536		
Number of languages known	-5.550	6.655	-.387	-.834	.421	.200	5.007
Number of languages of Instruction	-4.299	11.067	-.121	-.388	.704	.441	2.265
% Time exposed to Lang	.757	.486	.423	1.558	.145	.584	1.713
% Time exposed to Lang	-.887	.531	-.587	-1.670	.121	.347	2.880
% Time exposed to Lang	.706	.556	.430	1.268	.229	.374	2.675
Exp Lang 5 or more % of time	-.952	2.238	-.280	-.425	.678	.099	10.118
Chose to Read Lang1 % of time	1.455	1.861	1.872	.782	.449	.007	133.478
Chose to Read Lang2 % of time	1.548	2.062	.987	.751	.467	.025	40.295
Chose to Read Lang3 % of time	2.659	2.100	2.608	1.266	.230	.010	98.901
Chose to Read Lang4 % of time	2.604	2.239	1.266	1.163	.268	.036	27.626
Chose to Read Lang5 % of time	.746	2.867	.135	.260	.799	.159	6.293
Gender	-4.487	12.566	-.115	-.357	.727	.412	2.426
Highest Education level	1.254	9.640	.055	.130	.899	.244	4.106
Age Category	11.595	8.992	.473	1.290	.222	.319	3.135
Dominant Language 1	2.794	1.986	.434	1.407	.185	.451	2.216
Dominant Language 2	4.528	2.768	.618	1.636	.128	.301	3.326
Dominant Language 3	2.774	2.659	.380	1.043	.317	.323	3.093
Colour							
(Constant)	-367.245	107.709		-3.410	.005		
Number of languages known	-1.676	3.562	-.128	-.471	.646	.200	5.007
Number of languages of Instruction	-.411	5.923	-.013	-.069	.946	.441	2.265
% Time exposed to Lang	1.319	.260	.805	5.075	.000	.584	1.713
% Time exposed to Lang	-.552	.284	-.399	-1.941	.076	.347	2.880
% Time exposed to Lang	.582	.298	.387	1.953	.075	.374	2.675
Exp Lang 5 or more % of time	-2.325	1.198	-.749	-1.942	.076	.099	10.118
Chose to Read Lang1 % of time	3.184	.996	4.478	3.197	.008	.007	133.478

(continued)

Table 9.12
Coefficients of the SWCIT scale (Continued)

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
Chose to Read Lang2 % of time	3.710	1.104	2.587	3.362	.006	.025	40.295
Chose to Read Lang3 % of time	4.105	1.124	4.403	3.652	.003	.010	98.901
Chose to Read Lang4 % of time	4.959	1.199	2.636	4.137	.001	.036	27.626
Chose to Read Lang5 % of time	.879	1.535	.174	.573	.578	.159	6.293
Gender	-13.955	6.725	-.392	-2.075	.060	.412	2.426
Highest Education level	.867	5.160	.041	.168	.869	.244	4.106
Age Category	8.790	4.812	.392	1.827	.093	.319	3.135
Dominant Language 1	1.821	1.063	.309	1.713	.112	.451	2.216
Dominant Language 2	6.284	1.481	.938	4.243	.001	.301	3.326
Dominant Language 3	4.873	1.423	.730	3.424	.005	.323	3.093
Word-Colour							
(Constant)	182.841	145.045		1.261	.231		
Number of languages known	-4.187	4.796	-.382	-.873	.400	.200	5.007
Number of languages of Instruction	-2.049	7.976	-.076	-.257	.802	.441	2.265
% Time exposed to Lang	-.765	.350	-.559	-2.187	.049	.584	1.713
% Time exposed to Lang	-.063	.383	-.055	-.166	.871	.347	2.880
% Time exposed to Lang	-.567	.401	-.451	-1.413	.183	.374	2.675
Exp Lang 5 or more % of time	.359	1.613	.138	.222	.828	.099	10.118
Chose to Read Lang1 % of time	-.931	1.341	-1.567	-.694	.501	.007	133.478
Chose to Read Lang2 % of time	-1.264	1.486	-1.055	-.851	.412	.025	40.295
Chose to Read Lang3 % of time	-.776	1.514	-.995	-.512	.618	.010	98.901
Chose to Read Lang4 % of time	-.526	1.614	-.335	-.326	.750	.036	27.626
Chose to Read Lang5 % of time	-.880	2.066	-.209	-.426	.678	.159	6.293
Gender	3.778	9.056	.127	.417	.684	.412	2.426
Highest Education level	-6.153	6.948	-.350	-.886	.393	.244	4.106
Age Category	-2.942	6.480	-.157	-.454	.658	.319	3.135

Table 9.12
Coefficients of the SWCIT scale (Continued)

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
Dominant Language 1	1.623	1.432	.330	1.133	.279	.451	2.216
Dominant Language 2	.587	1.995	.105	.294	.774	.301	3.326
Dominant Language 3	-.234	1.916	-.042	-.122	.905	.323	3.093

According to Table 9.11 a significant regression equations could only be found for one of the three SWCIT scores; with the Word score consisting of ($F(17,12) = .665$, $p < .785$), the Colour score of ($F(17,12) = 3.296$, $p < .020$) and the Word-Colour score of ($F(17,12) = .836$, $p < .642$). The R scores for the three subsets are reflected in Table 9.9 as .696 for the Word score, .908 for the Colour score and .736 for the Word-Colour score. Table 9.10 also depicts the R^2 score as .485 for the Word score, .824 for the Colour score and .542 for the Word-Colour score. There were no significant predictors for the Word or Word-Colour scores; however Table 9.12 indicates that percentage of time exposed to language 1, percentage of time chosen to read in language 1, 2, 3 and 4, and dominant language 2 and 3 were all significant predictors of Colour scores.

Table 9.13
Model Summary of the D-KEFS: Design Fluency scale

Model	R	R^2	Adjusted R^2	Std. Error of Estimate	Change Statistics R Square Change	Change Statistics F Change	Change Statistics df1	Change Statistics df2	Change Statistics Sig. F Change
Condition1	.911[a]	.830	.589	1.438	.830	3.443	17	12	.017
Condition 1 Total Errors	.862[a]	.744	.381	.972	.744	2.050	17	12	.105
Condition 2	.817[a]	.667	.195	2.471	.667	1.412	17	12	.275
Condition 2 Total Errors	.827[a]	.684	.236	1.827	.684	1.526	17	12	.231
Condition 3	.666[a]	.443	-.345	2.493	.443	.562	17	12	.865
Condition 3 Total Errors	.879[a]	.773	.450	2.376	.773	2.398	17	12	.064
Total Set Loss	.820[a]	.672	.207	3.231	.672	1.444	17	12	.262
Total Repetition	.748[a]	.559	-.065	2.787	.559	.896	17	12	.593
Design Accuracy	.817[a]	.668	.197	10.835	.668	1.418	17	12	.273

Table 9.14

ANOVA of the D-KEFS: Design Fluency scale

Model	Sum of Squares	df	Mean Square	F	Sig.
Condition 1					
Regression	121.048	17	7.120	3.443	.017[b]
Residual	24.818	12	2.068		
Total	145.867	29			
Condition 1 Total Errors					
Regression	32.951	17	1.938	2.050	.105[b]
Residual	11.349	12	.946		
Total	44.300	29			
Condition 2					
Regression	146.603	17	8.624	1.412	.275[b]
Residual	73.264	12	6.105		
Total	219.867	29			
Condition 2 Total Errors					
Regression	86.626	17	5.096	1.526	.231[b]
Residual	40.074	12	3.340		
Total	126.700	29			
Condition 3					
Regression	59.412	17	3.495	.562	.865[b]
Residual	74.588	12	6.216		
Total	134.000	29			
Condition 3 Total Errors					
Regression	230.228	17	13.543	2.398	.064[b]
Residual	67.772	12	5.648		
Total	298.000	29			
Total Set Loss					
Regression	256.229	17	15.072	1.444	.262[b]
Residual	125.238	12	10.436		
Total	381.467	29			
Total Repetition					
Regression	118.274	17	6.957	.896	.593[b]
Residual	93.192	12	7.766		
Total	211.467	29			
Design Accuracy					
Regression	2830.050	17	166.474	1.418	.273[b]
Residual	1408.650	12	117.388		

Table 9.15

Coefficients of the D-KEFS: Design Fluency scale

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Condition 1							
(Constant)	-1.355	13.371		-.101	.921		
Number of languages known	-.220	.442	-.132	-.497	.628	.200	5.007
Number of languages of Instruction	.177	.735	.043	.240	.814	.441	2.265
% Time exposed to Lang	-.013	.032	-.063	-.401	.695	.584	1.713
% Time exposed to Lang	.058	.035	.332	1.645	.126	.347	2.880
% Time exposed to Lang	-.059	.037	-.311	-1.598	.136	.374	2.675
Exp Lang 5 or more % of time	-.094	.149	-.239	-.630	.540	.099	10.118
Chose to Read Lang1 % of time	.054	.124	.606	.440	.667	.007	133.478
Chose to Read Lang2 % of time	.066	.137	.364	.481	.639	.025	40.295
Chose to Read Lang3 % of time	.074	.140	.631	.533	.604	.010	98.901
Chose to Read Lang4 % of time	.329	.149	1.386	2.214	.047	.036	27.626
Chose to Read Lang5 % of time	-.329	.190	-.515	-1.725	.110	.159	6.293
Gender	-.176	.835	-.039	-.211	.837	.412	2.426
Highest Education level	-2.452	.640	-.924	-3.828	.002	.244	4.106
Age Category	2.200	.597	.776	3.683	.003	.319	3.135
Dominant Language 1	.307	.132	.412	2.325	.038	.451	2.216
Dominant Language 2	.247	.184	.292	1.343	.204	.301	3.326
Dominant Language 3	.271	.177	.322	1.535	.151	.323	3.093
Condition 1 Total Errors							
(Constant)	-21.412	9.041		-2.368	.036		
Number of languages known	.949	.299	1.038	3.175	.008	.200	5.007
Number of languages of Instruction	1.361	.497	.602	2.737	.018	.441	2.265
% Time exposed to Lang	.015	.022	.131	.684	.507	.584	1.713
% Time exposed to Lang	.001	.024	.007	.028	.978	.347	2.880
% Time exposed to Lang	-.019	.025	-.181	-.758	.463	.374	2.675
Exp Lang 5 or more % of time	-.121	.101	-.559	-1.203	.252	.099	10.118

(continued)

Table 9.15

Coefficients of the D-KEFS: Design Fluency scale (Continues)

Model	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Chose to Read Lang1 % of time	.164	.084	3.306	1.958	.074	.007	133.478
Chose to Read Lang2 % of time	.173	.093	1.735	1.871	.086	.025	40.295
Chose to Read Lang3 % of time	.101	.094	1.561	1.074	.304	.010	98.901
Chose to Read Lang4 % of time	.168	.101	1.280	1.666	.121	.036	27.626
Chose to Read Lang5 % of time	.238	.129	.677	1.847	.090	.159	6.293
Gender	-.254	.565	-.102	-.449	.661	.412	2.426
Highest Education level	.749	.433	.512	1.730	.109	.244	4.106
Age Category	-.557	.404	-.357	-1.378	.193	.319	3.135
Dominant Language 1	-.040	.089	-.098	-.451	.660	.451	2.216
Dominant Language 2	.043	.124	.092	.346	.735	.301	3.326
Dominant Language 3	.155	.119	.334	1.299	.218	.323	3.093
Condition 2							
(Constant)	6.011	22.973		.262	.798		
Number of languages known	1.062	.760	.521	1.398	.187	.200	5.007
Number of languages of Instruction	1.265	1.263	.251	1.001	.337	.441	2.265
% Time exposed to Lang	-.007	.055	-.029	-.134	.896	.584	1.713
% Time exposed to Lang	.022	.061	.101	.358	.727	.347	2.880
% Time exposed to Lang	-.034	.064	-.144	-.530	.606	.374	2.675
Exp Lang 5 or more % of time	-.289	.255	-.600	-1.132	.280	.099	10.118
Chose to Read Lang1 % of time	-.009	.212	-.081	-.042	.967	.007	133.478
Chose to Read Lang2 % of time	.036	.235	.161	.153	.881	.025	40.295
Chose to Read Lang3 % of time	-.058	.240	-.402	-.243	.812	.010	98.901
Chose to Read Lang4 % of time	.199	.256	.682	.778	.451	.036	27.626
Chose to Read Lang5 % of time	-.288	.327	-.367	-.879	.397	.159	6.293

(continued)

Table 9.15

Coefficients of the D-KEFS: Design Fluency scale (Continues)

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Gender	-.562	1.434	-.102	-.392	.702	.412	2.426
Highest Education level	-2.178	1.100	-.668	-1.979	.071	.244	4.106
Age Category	1.717	1.026	.494	1.673	.120	.319	3.135
Dominant Language 1	-.328	.227	-.359	-1.447	.173	.451	2.216
Dominant Language 2	-.096	.316	-.093	-.305	.766	.301	3.326
Dominant Language 3	.320	.304	.309	1.053	.313	.323	3.093
Condition 2 Total Errors							
(Constant)	-23.954	16.990		-1.410	.184		
Number of languages known	.414	.562	.268	.738	.475	.200	5.007
Number of languages of Instruction	-1.010	.934	-.264	-1.081	.301	.441	2.265
% Time exposed to Lang	-.020	.041	-.106	-.499	.627	.584	1.713
% Time exposed to Lang	-.065	.045	-.399	-1.449	.173	.347	2.880
% Time exposed to Lang	.029	.047	.164	.617	.549	.374	2.675
Exp Lang 5 or more % of time	.004	.189	.010	.019	.985	.099	10.118
Chose to Read Lang1 % of time	.287	.157	3.426	1.826	.093	.007	133.478
Chose to Read Lang2 % of time	.266	.174	1.573	1.526	.153	.025	40.295
Chose to Read Lang3 % of time	.280	.177	2.550	1.579	.140	.010	98.901
Chose to Read Lang4 % of time	.162	.189	.732	.858	.408	.036	27.626
Chose to Read Lang5 % of time	.124	.242	.209	.513	.617	.159	6.293
Gender	.052	1.061	.012	.049	.962	.412	2.426
Highest Education level	.220	.814	.089	.270	.792	.244	4.106
Age Category	.489	.759	.185	.644	.532	.319	3.135
Dominant Language 1	-.106	.168	-.153	-.635	.538	.451	2.216
Dominant Language 2	-.053	.234	-.067	-.226	.825	.301	3.326
Dominant Language 3	-.374	.224	-.475	-1.665	.122	.323	3.093
Condition 3							
(Constant)	19.840	23.179		.856	.409		
Number of languages known	-.671	.767	-.422	-.875	.399	.200	5.007

(continued)

Table 9.15

Coefficients of the D-KEFS: Design Fluency scale (Continues)

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Number of languages of Instruction	.599	1.275	.152	.470	.647	.441	2.265
% Time exposed to Lang	-.074	.056	-.371	-1.315	.213	.584	1.713
% Time exposed to Lang	.023	.061	.139	.381	.710	.347	2.880
% Time exposed to Lang	-.050	.064	-.277	-.785	.447	.374	2.675
Exp Lang 5 or more % of time	.101	.258	.269	.393	.701	.099	10.118
Chose to Read Lang1 % of time	-.115	.214	-1.339	-.538	.600	.007	133.478
Chose to Read Lang2 % of time	-.131	.238	-.756	-.553	.591	.025	40.295
Chose to Read Lang3 % of time	-.134	.242	-1.184	-.553	.591	.010	98.901
Chose to Read Lang4 % of time	.005	.258	.021	.019	.985	.036	27.626
Chose to Read Lang5 % of time	-.245	.330	-.401	-.743	.472	.159	6.293
Gender	-.405	1.447	-.094	-.280	.784	.412	2.426
Highest Education level	-.528	1.110	-.207	-.475	.643	.244	4.106
Age Category	.575	1.036	.212	.555	.589	.319	3.135
Dominant Language 1	-.016	.229	-.022	-.069	.946	.451	2.216
Dominant Language 2	.153	.319	.189	.480	.640	.301	3.326
Dominant Language 3	.216	.306	.267	.705	.495	.323	3.093
Condition 3 Total Errors							
(Constant)	-70.265	22.095		-3.180	.008		
Number of languages known	.557	.731	.235	.763	.460	.200	5.007
Number of languages of Instruction	.226	1.215	.039	.186	.856	.441	2.265
% Time exposed to Lang	.121	.053	.408	2.265	.043	.584	1.713
% Time exposed to Lang	-.007	.058	-.030	-.127	.901	.347	2.880
% Time exposed to Lang	.068	.061	.249	1.105	.291	.374	2.675
Exp Lang 5 or more % of time	-.219	.246	-.391	-.893	.389	.099	10.118
Chose to Read Lang1 % of time	.680	.204	5.291	3.327	.006	.007	133.478

(continued)

Table 9.15

Coefficients of the D-KEFS: Design Fluency scale (Continues)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
Chose to Read Lang2 % of time	.737	.226	2.845	3.256	.007	.025	40.295
Chose to Read Lang3 % of time	.726	.231	4.312	3.150	.008	.010	98.901
Chose to Read Lang4 % of time	.673	.246	1.980	2.736	.018	.036	27.626
Chose to Read Lang5 % of time	.564	.315	.618	1.791	.099	.159	6.293
Gender	-.293	1.380	-.046	-.212	.835	.412	2.426
Highest Education level	-.774	1.058	-.204	-.732	.478	.244	4.106
Age Category	.852	.987	.210	.863	.405	.319	3.135
Dominant Language 1	-.089	.218	-.083	-.407	.691	.451	2.216
Dominant Language 2	-.300	.304	-.248	-.986	.344	.301	3.326
Dominant Language 3	.135	.292	.112	.461	.653	.323	3.093
Total Set Loss							
(Constant)	-76.002	30.035		-2.530	.026		
Number of languages known	.815	.993	.304	.821	.428	.200	5.007
Number of languages of Instruction	-.612	1.652	-.092	-.370	.718	.441	2.265
% Time exposed to Lang	.142	.072	.425	1.964	.073	.584	1.713
% Time exposed to Lang	-.023	.079	-.080	-.285	.781	.347	2.880
% Time exposed to Lang	.063	.083	.204	.753	.466	.374	2.675
Exp Lang 5 or more % of time	-.175	.334	-.276	-.525	.609	.099	10.118
Chose to Read Lang1 % of time	.755	.278	5.193	2.717	.019	.007	133.478
Chose to Read Lang2 % of time	.795	.308	2.711	2.582	.024	.025	40.295
Chose to Read Lang3 % of time	.776	.313	4.073	2.476	.029	.010	98.901
Chose to Read Lang4 % of time	.710	.334	1.846	2.123	.055	.036	27.626
Chose to Read Lang5 % of time	.668	.428	.648	1.562	.144	.159	6.293
Gender	.137	1.875	.019	.073	.943	.412	2.426
Highest Education level	.332	1.439	.077	.231	.821	.244	4.106

(continued)

Table 9.15

Coefficients of the D-KEFS: Design Fluency scale (Continues)

Model	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Age Category	.026	1.342	.006	.019	.985	.319	3.135
Dominant Language 1	-.235	.296	-.196	-.794	.443	.451	2.216
Dominant Language 2	-.363	.413	-.265	-.880	.396	.301	3.326
Dominant Language 3	-.050	.397	-.037	-.126	.902	.323	3.093
Total Repetition							
(Constant)	-39.629	25.909		-1.530	.152		
Number of languages known	1.106	.857	.554	1.291	.221	.200	5.007
Number of languages of Instruction	1.188	1.425	.241	.834	.421	.441	2.265
% Time exposed to Lang	-.027	.063	-.109	-.434	.672	.584	1.713
% Time exposed to Lang	-.049	.068	-.234	-.719	.486	.347	2.880
% Time exposed to Lang	.015	.072	.066	.209	.838	.374	2.675
Exp Lang 5 or more % of time	-.161	.288	-.341	-.560	.586	.099	10.118
Chose to Read Lang1 % of time	.376	.240	3.471	1.568	.143	.007	133.478
Chose to Read Lang2 % of time	.381	.265	1.747	1.436	.176	.025	40.295
Chose to Read Lang3 % of time	.331	.270	2.336	1.226	.244	.010	98.901
Chose to Read Lang4 % of time	.293	.288	1.023	1.016	.330	.036	27.626
Chose to Read Lang5 % of time	.257	.369	.335	.698	.499	.159	6.293
Gender	-.632	1.618	-.117	-.390	.703	.412	2.426
Highest Education level	-.138	1.241	-.043	-.111	.914	.244	4.106
Age Category	.758	1.158	.222	.655	.525	.319	3.135
Dominant Language 1	-6.197E-5	.256	.000	.000	1.00	.451	2.216
Dominant Language 2	.054	.356	.053	.151	.882	.301	3.326
Dominant Language 3	-.034	.342	-.033	-.099	.923	.323	3.093
Design Accuracy							
(Constant)	266.992	100.732		2.651	.021		
Number of languages known	-5.805	3.331	-.649	-1.743	.107	.200	5.007
Number of languages of Instruction	-.466	5.539	-.021	-.084	.934	.441	2.265

(continued)

Table 9.15

Coefficients of the D-KEFS: Design Fluency scale (Continues)

Model	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
% Time exposed to Lang	-.366	.243	-.328	-1.506	.158	.584	1.713
% Time exposed to Lang	.235	.266	.250	.885	.394	.347	2.880
% Time exposed to Lang	-.316	.279	-.309	-1.134	.279	.374	2.675
Exp Lang 5 or more % of time	.677	1.120	.320	.604	.557	.099	10.118
Chose to Read Lang1 % of time	-1.639	.932	-3.384	-1.760	.104	.007	133.478
Chose to Read Lang2 % of time	-1.613	1.032	-1.651	-1.563	.144	.025	40.295
Chose to Read Lang3 % of time	-1.560	1.051	-2.456	-1.484	.164	.010	98.901
Chose to Read Lang4 % of time	-.802	1.121	-.626	-.715	.488	.036	27.626
Chose to Read Lang5 % of time	-1.674	1.435	-.487	-1.166	.266	.159	6.293
Gender	-.930	6.289	-.038	-.148	.885	.412	2.426
Highest Education level	-4.036	4.825	-.282	-.836	.419	.244	4.106
Age Category	.593	4.501	.039	.132	.897	.319	3.135
Dominant Language 1	.470	.994	.117	.473	.645	.451	2.216
Dominant Language 2	.985	1.385	.216	.711	.491	.301	3.326
Dominant Language 3	1.012	1.331	.223	.760	.462	.323	3.093

The last multiple regression is represented by Table 9.13, 9.14 and 9.15 that was conducted for the D-KEFS: Design Fluency scale based on number of languages known, number of languages of instruction, the percentage of time exposed to each language, percentage of time chosen to read in each language, gender, highest education level, age category and the top three dominant languages. This scale has three conditions that are of importance for interpretation, as well as each of the three conditions errors, a total set loss, a total repetition and design accuracy.

Table 9.14 indicates that a significant regression equations could only be found for one of the D-KEFS: Design Fluency scores; with that being the Condition 1 score consisting of ($F(17,12) = 3.443$, $p < .017$). The other scores obtained the following equations; Condition 1 Total Errors at ($F(17,12) = 2.050$, $p < .105$), Condition 2 at ($F(17,12) = 1.412$, $p < .275$), Condition 2 Total Errors at ($F(17,12) = 1.526$, $p < .231$), Condition 3 at ($F(17,12) = .562$, $p < .865$), Condition 3 Total Errors at ($F(17,12) = 2.398$, $p < .064$), Total set loss at ($F(17,12) = 1.444$, $p < .262$), Total Repetition at ($F(17,12) = .896$, $p < .593$) and finally Design Accuracy at ($F(17,12) = 1.418$, $p < .273$). Table 4.12 denotes the R scores for the components of the D-KEFS: Design Fluency scale as follows; Condition 1 at .911, Condition 1 Total Errors at .862, Condition 2 at .817, Condition 2 Total Errors at .827, Condition 3 at .666, Condition 3 Total Errors at .879, Total set loss at 820, Total Repetition at .748 and Design fluency at 817. Table 4.12 also designates the R^2 scores for the components of the D-KEFS: Design Fluency scale as follows; Condition 1 at .830, Condition 1 Total Errors at .744, Condition 2 at .667, Condition 2 Total Errors at .684, Condition 3 at .443, Condition 3 Total Errors at .773, Total set loss at 672, Total Repetition at .559 and Design fluency at 668.

According to Table 9.15 the significant predictors for D-KEFS: Design Fluency scale Condition 1 were: percentage of time chosen to read in language 4, highest level of education, age category and dominant language 1.

10. Discussion

The influence of bi/multilingualism on executive functioning has been emphasised to great lengths by numerous previous studies (Mueller-Gathercole et al., 2010; Bialystok, 2001; Bialystok et al., 2009; Zied et al, 2004; Bialystok et al., 2004). This included the assertion that acquiring bi/multilingual proficiency is accompanied with an increased cognitive flexibility, an amplified strain on fluency, as well as advanced inhibitory control and planning (Bialystok, 2001; Bialystok et al., 2009; Bialystok et al., 2004). However, the language variable has been mainly studied categorically and studies of this kind with multilingual are not common (Maria et al., 2007). Thus the current research study aims at addressing these shortcomings in previous literature by exploring the relationship between self reported language experience and executive functioning performance in a sample of multilingual young adults.

In order to facilitate this investigation executive functioning was conceptualised of as four distinct sub components and each component was understood in terms of the data that resulted from performance on purposely selected neuropsychological tests. These include fluency investigated with D-KEFS - Design Fluency Test conditions 1, 2 and 3 scores, as well as the amount of errors obtained per condition, the total set loss for the measure, total amount of repetitions preformed in the measure and final design accuracy; as well as COWAT totals and total errors perpetrated. In turn cognitive flexibility is associated with the MoCA Trail Making exercise and SWCIT’s Word, Colour and Word-Colour trails scores. SWCIT’s Word, Colour and Word-Colour trails scores and D-KEFS - Design Fluency Test were used to establish the relationship with inhibition. Finally planning was investigated by making use of the MoCA Clock Drawing exercise and the D-KEFS - Design Fluency Test as set out above. The relationship between the performances of participants on the different components of executive functioning and particular aspects of the language experience, as assessed by the LEAP-Q was then analyzed with use of multiple linear regression and the results will now be discussed in-depth.

Firstly demographic information generated by this study is considered for discussion. According to percentage distributions obtained the sample contained more female participants than male participants in a ratio of 60 to 40 percent. This factor was not selected for during sampling and these scores came to reflect a discrepancy with the South African population tendency. Although a tendency of more females to males are shared with the larger population distribution of South Africa; the census results indicated a 51.3% versus 48.7% ratio indicating not nearly in the same proportions (StatsSA, 2012). In terms of age all participants in this study fell between the ages of 18 and 25 years old; the three age categories within which these ages were divided indicated that the majority of participants were 21 years of age or older. This age cohort represents the ideal group for testing of these influences since it is believe that neural processing speed reaches its peak during young adulthood (Salthouse, 2003).

According to Shuttleworth-Edwards (2012) both differing quality standards of education and levels of educational attainments can drastically influence psychometric test performance. Thus although quality of education for each participant could not without reasonable doubt be established in this study, the highest level of education of participants was recorded and noted in terms of level of education for further comparison with executive performance. As a minimum requirement participants had to have obtained a senior certificate in order to assure proficiency for testing; the proportion of the sample that only held this qualification also came to 30%. A further 30% of the sample held a bachelors degree or a national diploma; both requiring three years to complete. The final and also highest academic qualification observed in this sample was participants with honours degrees, which made up 40% of the sample. Although this was an educated sample it was also not skewed by any individuals who had exceptionally high academic qualifications like Masters or PhD qualifications.

The issues of what language to educate youths in has been debated for decades in South Africa (Nel & Müller, 2010). According to this study the majority of participants received schooling in only one language. The language was primarily English and seeing that none of the participant's home language is English; this implies they were not educated in their first language but rather in their second or sometimes even third or fourth language. The work by Heugh (1999) notes that no real improvement has occurred with regards to educational language reform since the Soweto student uprisings of 1976 that centered on this very subject and that the situation actually worsened with the South African government rushing the implementation of new educational curriculums without through consideration of the relationship between learning and the languages learning will take place in. More recent research by Banda (2009) also emphasizes how the South African education system has become so caught up in debates around mother tongue instruction that the valuable possibility of integrating African languages into multilingual education programs have fallen by the wayside.

In accordance with the findings, the most prominent distribution of number of languages participants reported they could speak spread between three and five; this accounted for 86.7% of the sample. The lower limit of three represents the selection criterion of sampling in order to meet the operational definition of multilingualism. The majority (36.7%) of participants spoke four South African languages. The most prevalent first dominant language amongst participants in this study was Sotho with a frequency of n=10, whereas English came in as a close second with a frequency of n=9. When considering this prevalence two important characteristics come to play. Firstly is the fact that the southern region of Gauteng where the research was conducted is known to be inhabited by Sotho speaking individuals, due to its close proximity to the Free State (StatsSA, 2012; Lewis, Simons, & Fennig, 2015). The prominence of the English dominance could possibly be attributed to the primarily English schooling these participants received as discussed above. This also links to the fact that the second most dominant language found amongst participants was English.

The third most dominant language was found to be Zulu. Despite the fact that Zulu is a particularly regional language and traditionally associated with the more eastern coastal regions of South Africa; the 2011 South African census found Zulu to be the most frequently spoken language in Gauteng and thus can be heard all around this central province (StatsSA, 2012; Lewis et al., 2015). In addition to its provincial status Zulu was also found to be the most abundantly spoken language country wide (StatsSA, 2012). It is important to take into consideration the unique language acquisition interplay found in South Africa. Conducting research in this milieu has many nuances including keeping in mind that unlike most other international research studies the acquisition of additional languages in South Africa does not necessarily occur in the same ways as elsewhere in the world (Hacksley, Jeffery, Mesthrie, Reddy, & Cromarty, 2007; Nel & Müller, 2010). Hacksley et al. (2007) expand on this notion by remarking on the pertinent divide between how multilingualism is lived day to day in the South African streets and how it is conceived of by the so called ‘guardians’ of language. It is believed that in South Africa language acquisition often comes from submersion and exposure, rather than formal or intentional acquisition (Nel & Müller, 2010). Based on this information, the census results (StatsSA, 2012) and the fact that the majority of participants do not list Zulu as their home language, nor were they educated in it; the deduction could be made that Zulu gained status as the third most dominant language in thus study through participants being environmentally exposed to it and in so doing acquiring it. This early and extensive exposure could also be understood as linked to the position presented by Bialystok

(1988) where executive control functions are developed earlier by bi/multilingual youths than by their purely monolingual counterparts. This language diversity, fluctuating bi/multilingual exposure and regional variance of languages all combine to pose a significant challenge for sampling, especially in a smaller study like this one.

When considering the relationship between dependant and independent variables it was most prominently noted that the MoCA's two subsets, the Trail Making and Clock Drawing tests, did not produce any significant results in terms of a relationships with self reported language experience or demographic information. These issues are pointing to the need for local validation of this test, with a strong emphasis in its correlation with other executive function measurements (Robbins et al., 2013). According to Robbins et al. (2013) the MoCA has been researched and validated for use in numerous international counties, however no local norms for South African exist. In addition to this both HIV status (which was not controlled for by this study) and education have both been found to be significant predictors of MoCA performance and are exceptionally relevant in the South African context (Robbins et al., 2013).

The MoCA Clock Drawing assessment screened for planning ability; thus the non significance indicated that no relationship was found between planning as executive function and self reported language experience. An interesting observation during testing of this function was that 10% of the participants (n=3) queried whether they were to draw a digital or analogue clock; this was despite very clear instructions to set the clock's hands to the specified time. One participant engaged the activity only to later self realise their error of drawing a digital clock and self corrected. This clearly suggests other variables affecting the performance beyond that should be further explored. The Trail Making assessment in turn screened for cognitive flexibility; thus no significant relationship could be established between cognitive flexibility as screened for by the Trail Making assessment and the independent variables as set out in accordance with self reported language experience and demographic information.

Both of these findings stand in stark contrast to the majority of previous research that considered the effects of bi/multilingualism on executive functions (Bialystok & Craik, 2010; Novick et al., 2005; Bialystok, 2007). Bialystok (2007) notes that planning, as assessed for by the Clock Drawing exercise, is utilised by bi/multilinguals in order to regulate attention to competing linguistic systems and ultimately allow for fluency of presentation. Through this repetitive utilisation the planning then becomes optimised and thus creates a relationship between executive functioning and bi/multilingualism (Bialystok, 2007). The literature reports a similarly beneficial relationship between cognitive flexibility, as assessed by the Trail making exercise, and bi/multilingualism. It is believed that this beneficial attribute, along with greater creativity, is developed by continuously switching between language systems and their accompanying differing perspectives (Adesope, Lavin, Thompson, & Ungerleider, 2010; Peal, & Lambert, 1962).

The results obtained on this measure may point to several variables. One of the first to consider is that the MoCA is a cognitive screening assessment. This screening assessment as a whole was originally intended to pick up neurological impairment and thus separate items may not be psychometrically sound to be used as standalone tests for picking up the nuanced relationship being measured here (Nasreddine, 2016). As was observed during administration several participants also required further clarifications of the Trail Making instructions of the MoCA, suggesting limitations of the test with regards to the adaptability to this context. Finally it is also worth noting that the design of this research study did not allow for a comparison with an equivalent monolingual sample. Thus it may not have enough variability in the language experience spectrum to allow for more nuanced comparisons.

The COWAT results indicates that the score obtained from the FAS total had a significant relationship with percentage of time exposed to language 1 and 3, percentage of time chosen to read in language 1, 2, 3 and 5, age category and dominant language 1. These contributed to 52.6% of the variance in FAS total scores. The total amount of FAS errors did not render a significant regression equation. The COWAT was implemented in order to assess verbal fluency amongst participants and the significant results obtained here reflect existing literature (Michael & Gollan, 2005; Bialystok, 2009). Lexical access is believed to be more strained and less rapid in bi/multilinguals due to both interference between language systems and weaker retrieval pathways than in monolinguals (Michael & Gollan, 2005; Bialystok, 2009). The fact that performance on the FAS total was significantly influenced by time exposed to language 1 and 3 fits with this hypothesis since these languages would plausibly cause interference and in so doing influence the ability of participants to quickly and effectively retrieve words for each letter (Gollan et al., 2002). This is described as a joint activation problem and represents how the different language systems the participants possesses are simultaneous activated even though not all are being used (Bialystok et al., 2008).

In turn language 2 may have not shown significance since the second language for most participants was recorded as English, which was then also the language of assessment and thus interference would not have been caused as hypothesised by Michael and Gollan (2005) and Bialystok (2009). This could be regarded as differential interference as set out by Meuter, and Allport (1999) and Poarch, and van Hell (2012). Here it is expressed that competing language systems have a multifaceted relationship beyond the one dimensional competition for expression (Meuter, & Allport, 1999; Bialystok, 2009). This phenomenon of differential inhibition occurs when an individual is not equally fluent in both languages representing competing lexical systems; as was the case with the majority of participants in this study (Meuter, & Allport, 1999; Poarch, & van Hell, 2012). When this occurs it requires significantly less cognitive effort to suppress Language 2 (L2), which the person is less fluent in, than it does to suppress Langue 1 (L1) that is the most dominant language (Meuter, & Allport, 1999). The same argument of interference can be lobbied for the significant relationship with preference of reading language and dominant language.

The non significance of the FAS total errors scores indicates that there was no significant relationship to be found between the amount of errors participants made during the test and the independent variables as set out in accordance with self reported language experience and demographic information. This is to be expected since this study was conducted with a healthy population and a strong relationship with errors is commonly associated with pathology (Ross, 2001). This relationship with errors was also found in the work of Ferrett (2011) where she conducted research with a group of young, yet healthy Capetonian teenagers and found that despite their age participants rarely made more than one error per letter. It is believed that different variations of the COWAT may have differing levels of difficulty depending on the composition of letters used and the FAS combination is regarded as an easy composition (Barry, Bates & Labouvie, 2008). This combination however also generated the best variability in performance amongst healthy participants; when compared to more narrow distributions generated by other letter combinations (Barry et al., 2008). However this also implies that different versions of the test should not be used interchangeably (Barry et al., 2008). Loonstra et al. (2001) report on the complexity of the normative data of the COWAT in that although it is available in published form, this data was acquired over a long period of time, in small pieces from various different studies; thus opening itself up to numerous inconsistencies. Hence, there are no large trial comprehensive norms available from which to work with the COWAT (Loonstra et al., 2001).

The SWCIT in turn is composed of three trails; the first two (Word and Colour) acting as controls and the last (Word-Colour) testing for both cognitive flexibility and inhibitory control (Bialystok, 2008). For this measure only the Colour trail produced a significant regression equation. Percentage of time exposed to language 1, percentage of time chosen to read in language 1, 2, 3 and 4, and dominant language 2 and 3 all produced significant scores and are responsible for 57.4% of the variance in this score. The fact that the Colour trail had a significantly relationship with percentage of time chosen to read in language 1, 2, 3 and 4 may indicate that here the participants natural inclination to read and mentally interpret visual stimuli in a particular language is linked to the processing speed with which they can articulate their response. For example a participant who prefers to read in Sotho may see the red X's and read this in their minds as 'ghoebedi' (which is the word for the colour red in Sotho), but then have to translate it to 'red' before expressing it to an assessor. This links back to the simultaneous activation of language systems and is accounted for by the fact that verbalising responses through speech in a specific language would be initiated by a conceptually-driven process. This process takes the idea and maps it against available lexical information; in this case the different words known for a colour (Kroll, Bobb, Misra, & Guo, 2008). This can be compared to having to only read English words in the first Word trail and thus negating the need to activate this conceptually-driven process of mapping (Kroll et al., 2008).

The influence of second and third dominant languages on the significant result of the Colour trail and the strength of influence of these would then also play into this hypothesis. Green (1998) describes the Stroop task as equivalent to a translation task and highlights that the mechanism for selecting appropriate responses may be intimately connected to how language systems are represented in the minds of speakers. The Inhibitory control model is proposed by Green (1998) as a control system form the bilingual lexico-semantic system;

which needs regulations in order to facilitate the involvement of competing languages. The Inhibitory control model is made up of three loci of control; an executive one for creating and sustaining goals, one for language task schemas and lastly a one located within the bilingual lexico-semantic system (Green, 1998). According to this model the outputs from the bilingual lexico-semantic system are controlled by competing language task schemes; it is also essential that these schemes be created, sustained and managed in order to regulate the use of only a single language at a time (Green, 1998).

The Word and Word-Colour trails both did not produce significant regression equations. These results are quite contradictory to that of pre-existing research that rest on the crux that bi/multilingualism potentially promotes cognitive flexibility and inhibitory control (Bialystok et al., 2009; Bialystok, 2001; Bialystok & Craik, 2001). Mueller-Gathercole et al. (2010) explains how a greater Stroop effect is found amongst monolinguals compared to bi/multilinguals. This so called Stroop effect can be understood as a greater cognitive tax for the inconsonance between written word and colour of ink. Bialystok et al. (2008) isolated slower monolingual readers and tested them in the same regard in order to assess whether or not this discrepancy may be due to a hypothesised greater automaticity of reading amongst monolinguals. However Bialystok et al. (2008) results still showed a greater Stroop effect even amongst these monolinguals; thus rejecting that premise. The disparity in results obtained from this study may be in part due to methodological variables of this particular study for example the small sample size (Biau, Kernéis & Porcher, 2008), inter-rater inconsistencies Gwet (2014) or how this effect is less clear when the multilingualism is assessed as a continuum and not in a categorical manner.

In terms of the three D-KEFS's Design Fluency trails, their total errors, total set loss, total repetitions and design accuracy; a significant regression equation could only be found for the total score obtained from Condition 1. Condition 1 was shown to be significantly predicted by percentage of time chosen to read in language 4, highest level of education, age category and dominant language 1 and these elements accounted for 58.9% of the score variance. The D-KEFS: Design Fluency measure was utilised to test non-verbal fluency, planning, inhibition and cognitive switching (Kraybill & Suchy, 2008). This result for Condition 1 does correspond with supporting literature which emphasises the relationship between general fluency and bi/multilingualism (Bialystok et al., 2009). The significant relationship between performance on Condition 1 and highest level of education is particularly relevant within the South African context. Schooling has been intimately tied to the performance on cognitive function tests and with the South African history and ever persisting inequality of schooling, it can be expected that this would influence the participant's performance (Nel & Müller, 2010; Shuttleworth-Edwards, 2012). Condition 1 is also the very first part of the D-KEFS: Design Fluency measure and in light of the fact that it was noted that most participants struggled to understand the instructions initially. This could also have bearing as to why a relationship with dominant language 1 was shown due to the conceptual understanding differentiation between languages for each individual.

However this does not account for the underlying executive mechanisms in Conditions 2 or 3 that were not found to be significant. Conditions 1 accentuates planning and generating novel designs; however conditions 2 and 3 place a theoretical emphasis on inhibition that is shown to be non-significant in this study (Lloyd, 2010). Condition 3 alone also brings to the test a cognitive switching component that too falls sort in light of significance (Lloyd, 2010). Generally, literature places a much larger emphasis on verbal fluency (Vega-Mendoza, West, Sorace, Bak, 2015; Bialystok et al., 2009). There is also an overall disparity in literature available with regards to investigations around the relationship between non-verbal fluency and bi/multilingualism. With that said studies outside the realm of neuro-linguistics have investigated both verbal and non-verbal fluency and found that both these forms of fluency centrally rely on flexibility of processing (Ruff, Evans, & Marshall, 1986). According to Ozonoff et al. (1991) it is worth noting that planning and inhibition are intimately connected. Thus a possible link between the performance on verbal and non-verbal fluency is expected.

When executive demands increase and become ever more complex it is believed that bi/multilinguals have more executive resources at their disposal (Bialystok, 2007). Many of the constituents that were revealed as not having a significant relationship with the self reported language components and demographic information thus contradicted popular literature (Gathercole et al., 2010; Bialystok, 2001; Bialystok et al., 2009; Zied, 2004; Bialystok et al., 2004). If these discrepancies could not be explained by construct or instrument inconsistencies then there is a large likelihood that these could be accounted for by methodological limitations. Although these findings suggest dissociation between the presented independent and dependant variables; however before making a definite conclusion, it would be important to consider plausible limitations that might have had a strong interference on the ultimate results. One such limitation may be the relatively small sample of participants that was used in this study and that this sample had to accommodate for several practical constraints of the study and thus did not absolutely accurately represent the population (Marshall, 1996). These constraints included finding participants who could speak at least three South African languages and as a result having only Black participants in comparison with the reality of a racially diverse country (StatsSA, 2012). Seeing that assessments were conducted in a variety of settings potentially also added to its variability and so could the reality that assessments were conducted by two different researchers (Gwet, 2014). Despite the wealth of literature available on the influence of bi/multilingualism and cognitive functions; it is worth noting that a limitation with regards to comparability between studies is how this bi/multilingualism is operationalised (Gathercole et al., 2010).

Another pervasive element to consider is the linguistic landscape of South Africa. Firstly there is the fact that this study worked from a self reported language experience questionnaire and not proficiency tests. Although the LEAP-Q has excellent correlations between self reported and tested proficiency, the responses of the participants cannot be verified or guaranteed to be truthful (Marian et al., 2007). Secondly, despite the fact that all participants knew English and then other languages, it should perhaps also be considered which languages were listed by participants in order to meet the multilingual criteria. Linguistic distance is presented by Chiswick and Miller (2005) as the extent to which languages differ grammatically, in vocabulary and syntax, as well as a host of other aspects. It could be hypothesized that this increased cognitive flexibility and inhibitory control may not present as robustly in the South African sample as in its international counterparts due to the actual linguistic nature of the languages being spoken by the participants and this linguistic distance, or lack thereof. The reality of the South African linguistic landscape is that the majority of so called Bantu languages can be divided into two broad categories that are linguistically very similar and have a very large semantic overlap (van Wyk, 1995). Many of these languages that for example fall into the Nguni categorisation only differ in very minute ways and would thus not make use of a whole other cognitive pathway, nor would they need to be inhibited to the same extent if they have overlapping components (van Wyk, 1995; Bialystok, 2008). This stands in contrast with for example research done with an English and Russian sample of participants as set forth by Marian, Spivey, and Hirsch (2003) where participants held L1 and L2's with little to no semantic overlap. This theory of differential inhibition like expanded on in the discussion of interference is fortified by the work of Meuter, and Allport (1999) where it was established that asymmetric inhibition is regularly employed by low-proficiency bilingualism in order to balance out dominant and non dominant language suppression.

Cognitive research has however not paid much attention to the different effects of particular languages on cognition (Poarch, and van Hell, 2012). In turn this would create methodological issues around variations in bi/multilingualism; for example ‘repetitive bilingualism’ which would not be considered as true bi/multilingualism. This could potentially be a limitation to the research in the form of changing a participant’s multilingual status as set out for sampling, especially due to the self report nature of this study (Halsband, 2006).The limitations of this study will be further discussed in the following section.

11. Limitations & Recommendations

- The sample size of participants used in this study is relatively small which affects the assurance of generalizability of the obtained results beyond this study in accordance with Lee and Baskerville (2003). It would be recommended that future research employ larger samples in order to negate these shortcomings.
- As a result of the selected sampling techniques, as well as having to accommodate all the prerequisites of the study, the final sample ultimately did not very accurately reflect the greater South African population. This in turn also influences the generalisability of results (Kukull, & Ganguli, 2012). For future research it would be recommended that sampling techniques be reconsidered as well as just how the inclusionary criteria of the study might influence the ultimate composition of the sample.
- This research did not control for the novelty aspect of assessments; thus participants were not queries on whether they have previous exposure to any of the assessments. If this was the case previous exposure may lead to unforeseen advantage and influence the obtained scores (Gurd, Kischka, & Marshal, 2003). Thus the recommendation would be that future research includes test exposure as part of the screening criterion for selecting participants.
- The assessment battery that was chosen for this study consisted of measures that were originally not developed for the South African population which could potentially influence the psychometric properties if applied to this population (Shuttleworth-Edwards, 2010). A more in-depth investigation of the psychometric properties of the assessments and its applicability to the South African population would be recommended for further investigations of this kind.

- The MoCA's two subsets the Trail Making and Clock Drawing test have proven limiting in this study. Taking into consideration the screening nature of the MoCA it would be recommended that future research instead make use of alternative and extensive Trail Making and Clock Drawing assessments. For example the Clock Drawing Test (Royall, Mulroy, Chiodo, & Polk, 1999) and the Comprehensive Trail Making Test (Smith et al., 2008). The MoCA is traditionally regarded as a brief screening test for cognitive impairment and thus was not able deliver the level of sensitivity needed for this type of executive investigation (Nasreddine, 2016).
- Language experience was operationalised as self-reported language experience in this study. The self report aspect of this questionnaire opens it up to inconsistency through interpretation, as well as questions about honesty with regards to responses (Paulhus & Vazire, 2007). Thus future research would be recommended to consider actual proficiency scales.
- This study has not explored the unique linguistic interconnectedness of especially South African Bantu languages as set out by Lewis et al. (2015). As a recommendation this may be further explored in future research in order to find out just how much of an influence this may have both on the conceptualisation of multilingualism and on the results obtained in executive functioning tests.
- Language of instruction was considered as an independent variable in this study; however with the seeming prominence of the role of education on cognitive testing according to Shuttleworth-Edwards (2012), this can be taken further. It can be recommended that future research place a greater emphasis on the exploration of education history for their participants and how this affects their performance.
- Despite the through nature of the LEAP-Q, one other important aspect of language experience that was not included here is the age of language acquisition. According to

Boone, Victor, Wen, Razani, and Ponton, (2007) this component could potentially add meaningfully to the understanding of performance of participants and would be worth exploring in future research.

- This study controlled for the level of bi/multilingualism through participants own subjective perception of how well they had mastered a language. However the level of bi/multilingualism may be critical in determining the true extent of the relationship between bi/multilingualism and cognitive performance (Bialystok, 1988). Thus it would be recommended that more emphasis is placed on the exploration of just how level of bi/multilingualism can be more critically operationalised.

12. Conclusion

The research question set out by this study aimed at exploring the relationship between self reported language experience and executive functioning of multilinguals. Executive functioning was operationalised in this research to represent cognitive flexibility, inhibition, planning and fluency. The performance of participants on these cognitive functions was investigated with the aid of a neuropsychological test battery. The LEAP-Q Questionnaire allowed for the investigation of various aspects of language experience and proficiency. This information was also supplemented by an extensive demographic questionnaire. The investigation included an exploration of a possible link between executive function performance and preference of reading language; as well as an exploration of the plausible link between executive functions and exposure time to differential languages. The relationship between executive function performance and the number of languages know by participants was investigated; in addition to the exploration of the influence of participants top thee most dominant language reports. As per the results obtained and the discussion that has been offered, the following conclusions can be presented:

- Both subsets of the MoCA, the Trail Making and Clock Drawing exercises did not show a statistical significant relationship with self-reported language experience in this study.
- Percentage of time exposed to language 1 and 3, percentage of time chosen to read in language 1, 2, 3 and 5, age category and dominant language 1 all were indicated to have a significant relationship with the FAS total score for the COWAT. The total errors obtained in the FAS trails however bore no significant relationship to self reported language experience or demographic variables.
- From the three trails of the SWCIT only the Colour trail produced a significant relationship. Here percentage of time exposed to language 1, percentage of time

chosen to read in language 1, 2, 3 and 4, and dominant language 2 and 3 were credited with having a significant impact on Colour trail scores.

- Condition 1 from the D-KEFS: Design Fluency measure was the only component to produce a statistically significant result in terms of a plausible relationship with self reported language proficiency. In this study Condition 1 was reported to bare a significant relationship to percentage of time chosen to read in language 4, highest level of education, age category and dominant language 1.
- The MoCA Trail Making task and the SWCIT cognitive flexibility as an executive function was found to not bear a significant relationship with self reported language experience in this study.
- When considering the results from the MoCA Clock Drawing exercise and the D-KEFS: Design Fluency planning as an executive function was found to bear only a partial relationship with self reported language experience in this study.
- In accordance with the results from the D-KEFS: Design Fluency and the SWCIT inhibition as an executive function was found to bear some significance in terms of a relationship with self reported language experience in this study.
- Finally it can also be concluded from the results obtained from the COWAT and the D-KEFS: Design Fluency, that fluency as an executive function was found to exhibit a significant relationship with self reported language experience in this study.

13. Reference List

Adamek, P. M. (2004). Habits of household lingualism. *Teaching English as a Second or Foreign Language E-Journal, 8*(1): 1–24. Retrieved from http://tesl-ej.org/ej29/a1.html

Adesope, O. O., Lavin, T., Thompson, T., & Ungerleider, C. (2010). A systematic review and meta-analysis of the cognitive correlates of bilingualism. *Review of Educational Research, 80*(2), 207–245.

Alexander, N. (2012). The centrality of the language question in the social sciences and humanities in post-apartheid South Africa: Revisiting a perennial issue. *South African Journal of Science, 108*, 1-7.

Ardila, A. (2008). On the evolutionary origins of executive functions. *Brain and Cognition, 68*(1), 92-9. Doi:10.1016/j.bandc.2008.03.003

Baldo, J. V., Shimamura, A. P., Delis, D. C., Kramer, J., & Kaplan, E. (2001). Verbal and design fluency in patients with frontal lobe lesions. *Journal of the International Neuropsychological Society*, *7* (5), 586 – 596.

Banda, F. (2009). Critical perspectives on language planning and policy in Africa: Accounting for the notion of multilingualism. *Stellenbosch Papers in Linguistics Plus, 38*, 1-11.

Batty, R., Francis, A., Thomas, N., Hopwood, M., Ponsford, J., Johnston, L., & Rossell, S. (2014). Verbal fluency,clustering,andswitchinginpatientswithpsychosis followingtraumaticbraininjury(PFTBI). Psychiatry Research (2015). Retrieved from http://dx.doi.org/10.1016/j.psychres.2015.03.040i

Barry, D., Bates, M. E., & Labouvie, E. (2008). FAS and CFL forms of verbal fluency differ in difficulty: A meta-analytic study. *Applied Neuropsychology, 15*(2), 97-106.

Best, J.R., & Miller, P.H. (2010). A developmental perspective on executive function. *Child Development, 81*(6), 1641-60. Doi: 10.1111/j.1467-8624.2010.01499.x

Best, J.R., Miller, P.H., & Naglieri, J. A. (2011). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and Individual Differences, 21*(4), 327–336.

Bhattacherjee, A. (2012). *Social science research: Principles, methods, and practices*. Tampa, FL: Creative Commons Attribution-Non Commercial-ShareAlike 3.0

Biau, D. J., Kernéis, S., & Porcher, R. (2008). Statistics in Brief: The Importance of Sample Size in the Planning and Interpretation of Medical Research. *Clinical Orthopaedics and Related Research, 466*, 2282–2288.

Bialystok, E. (1988). Levels of bilingualism and levels of linguistic awareness. *Developmental Psychology, 24*, 560-567.

Bialystok, E. (2007). Cognitive effects of bilingualism: How linguistic experience leads to cognitive change. *International Journal of Bilingual Education and Bilingualism, 10*(3), 210-223. DOI: 10.2167/beb441.0

Bialystok, E. (2009). Bilingualism: The good, the bad, and the indifferent. Bilingualism: Language and Cognition, 12(1), 3–11.

Bialystok, E., & Craik, F. I. M. (2010). Cognitive and linguistic processing in the bilingual mind. *Current Directions in Psychological Science, 19*(1), 19-23. doi:10.1177/0963721409358571

Bialystok, E., Craik, F. I. M., Green, D. W., & Gollan, T. H. (2009). Bilingual minds. *Psychological Science in the Public Interest, 10*(3), 89–129. doi: 10.1177/1529100610387084

Bialystok, E. (2001). *Bilingualism in development: Language, literacy and cognition*. UK: Cambridge University Press.

Bialystok, E., & Craik, F. I. M. (2010). Cognitive and linguistic processing in the bilingual mind. Current Directions in Psychological Science, 19(1), 19-23.

Bialystok, E., Craik, F. I. M., & Luk, G. (2008). Cognitive control and lexical access in younger and older bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34*(4), 859-873.

Bialystok, E., Craik, F. I. M., & Luk, G. (2012). Bilingualism: Consequences for mind and brain. *Trends in Cognitive Science, 16*(4), 240–250.

Bialystok, E., Craik, F. I. M., Klein, R., & Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: Evidence from the Simon Task. *Psychology and Aging*, *19*, 290–303.

Brocki, K. C., & Bohlin, G. (2004). Executive functions in children aged 6 to 13: a dimensional and developmental study. *Developmental Neuropsychology*, *26*(2), 571-593.

Boone, K. B., Victor, T. L., Wen, J., Razani, J., & Ponton, M. The association between neuropsychological scores and ethnicity, language, and acculturation variables in a large patient population. *Archives of Clinical Neuropsychology, 22,* 355–365.

Bull, R., & Scerif, G. (2001). Executive functioning as a predictor of children's mathematics ability: Inhibition, switching, and working memory. *Developmental Neuropsychology, 19*(3), 273–293.

Carlson, S. M., & Meltzoff, A. N. (2008). Bilingual experience and executive functioning in young children. *National Institute of Health Public Access, 11*(2), 282–298. doi:10.1111/j.1467-7687.2008.00675.x.

Chiswick, B.R., & Miller, P.W. (2005). Linguistic distance: A quantitative measure of the distance between English and other languages. *Journal of Multilingual and Multicultural Development*, *26,* 1-11.

Corbett, B. A., Constantine, L. J., Hendren, R., Rockec, D., & Ozonoff, S. (2009). Examining executive functioning in children with autism spectrum disorder, attention deficit hyperactivity disorder and typical development. *Psychiatry Research*, *166*(2-3), 210–222.

Delis, D. C., Kaplan, E., &Kramer, J. H. (2001). *D-KEFS technical manual*. San Antonio, TX: Pearson.

Denckla, M. B. (1996). A theory and model of executive function: A neuropsychological perspective. In G. R. Lyon & N. A. Krasnegor (Eds.), *Attention, memory and executive function* (pp. 263–277). Baltimore, MD: Paul H. Brooks.

Diamond, A. (2013). Executive functions. *Annual Review Psychology, 64*,135–168.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4–12 years old. *Science, 333*(6045), 959–964.

Diaz, C., & Peraita, H. (2008). Neuropsychological evaluation and cognitive evolution of a bilingual Alzheimer patient. *Revista de Psicopatología y Psicología Clínica, 13*(3), 219-228.

Evans, R. W., Ruff, R. M., & Gualtieri, C. T. (1985). Verbal fluency and figural fluency in bright children. *Perceptual and Motor Skills, 61*, 699-709.

Eviatar, Z. (1997). Language experience and right hemisphere tasks: The effects of scanning habits and multilingualism. Brain and Language, 58, 157-173.

Ferrett, H. L. (2011). The adaptation and norming of selected psychometric tests for 12- to 15-year-old urbanized Western Cape adolescents (Doctoral dissertation, The

University of Stellenbosch, Stellenbosch, South Africa). Retrieved from http://scholar.sun.ac.za/handle/10019.1/17799

Figueroa, I. J., Youmans, R. J., & Shaw, T. H. (2014). *Cognitive Flexibility and Sustained Attention: See something, say something (even when it's not there).* Proceedings of the Human Factors and Ergonomics Society 58th Annual Meeting (pp.954- 958). Fairfax, United States of America. Retrieved from http://pro.sagepub.com/content/58/1/954.abstract?rss=1

Franceschini, R. (2001). Multilingualism and multicompetence: A conceptual view. *The Modern Language Journal, 95*(3), *344 -355.* doi: 10.1111/j.1540-4781.2011.01202.x0026-7902/11/344–355

Freitas, S., Simoes, M. R., Alves, L., & Santana, I. (2012). Montreal Cognitive Assessment: Influence of sociodemographic and health variables. *Archives of Clinical Neuropsychology*, *27*, 165–175.

Geurts, H. M., Verte, S., Oosterlaan, J., Roeyers, H., & Sergeant, J. A. (2004). How specific are executive functioning deficits in attention deficit hyperactivity disorder and autism?. *Journal of Child Psychology and Psychiatry*, *45*(4), 836–854.

Goel, V., & Grafman, J. (1994). Are the frontal lobes implicated in "planning" functions? Interpreting data from the Tower of Hanoi. *Neuropsychologia*, *33*(5), 623 – 642.

Golden, C. J., & Freshwater, S. M. (1998). *The Stroop Color and Word Test Manual*. Wood Dale, IL: Stoelting Co.

Golden, C. J., & Golden, Z. L. (2002). Patterns of performance on the Stroop Color and Word Test in children with learning, attentional and psychiatric disabilities. *Psychology in the Schools*, *39*(5), 489 – 495.

Gollan, T. H., Werner, G. A., & Montoya, R. I. (2002). Semantic and letter fluency in Spanish–English bilinguals. *Neuropsychology, 16*(4), 562–576.

Grafman, J., Litvan, I., Massaquoi, S., Stewart, S., Sirigu, A., & Hallett, M. (1992). Cognitive planning deficit in patients with cerebellar atrophy. *Neurology,* 42, 1493- 1496.

Green, D. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition, 1*, 67–81.

Grosjean, F. (1989). Neurolinguists, beware! The bilingual is not two monolinguals in one person. *Bilingualism and Neurolinguistics, 36*(1), 3 -15.

Grosjean, F. (2010). *Bilingual: Life and reality*. Cambridge, MA: Harvard University Press.

Gurd, J. M., Kischka, U., & Marshal, J. C. (2003). *Handbook of Clinical Neuropsychology*. New York, NY: Oxford University Press.

Gwet, K. L. (2014). *Handbook of inter-rater reliability: The Definitive Guide to Measuring the Extent of Agreement Among Raters* (4th ed.). Gaithersburg, MD: Advanced Analytics.

Hacksley, M., Jeffery, C., Mesthrie, R., Reddy, T., Wildsmith-Cromarty, R. 2007. *Towards a Nuanced View of Multilingualism.* On Behalf of the English National Language Body of the Pan South African Language Board. Retrieved from http://www.englishacademy.co.za/pansalb/multilingualism.pdf.

Hakuta, K. (1987). Degree of bilingualism and cognitive ability in mainland Puerto Rican children. *Child Development, 58*, 1372- 1388.

Halsband, U. (2006). Bilingual and multilingual language processing. *Journal of Physiology – Paris, 99*, 355–369.

Hammond, K. J. (1990). Case-based planning: A framework for planning from experience. *Cognitive science, 14*, 385-443.

Hedden, T., & Gabrieli,J. D., (2010). Shared and selective neural correlates of inhibition, facilitation, and shifting processes during executive control. NeuroImage, 51(1), 421-431.

Heugh, K. (1999). Languages, development and reconstructing education in South Africa. *International Journal of Educational Development, 19*, 301–313.

Homack, S., Lee, D., & Riccio, C. A. (2007). Test review: Delis-Kaplan Executive Function System. Journal of Clinical and Experimental Neuropsychology, 27(5), 599-609. doi:10.1080/13803390490918444

Hoops, S., Nazem, S., Siderowf, A. D., Duda, J. E., Xie, S. X., Stern, M. B., & Weintraub, D. (2009). Validity of the MoCA and MMSE in the detection of MCI and dementia in Parkinson disease. *Neurology, 7*(3), 1738 -1745.

Hyltenstam, K., & Abrahamsson, N. (2003). Maturational constraints in second language acquisition. In C. Doughty & M. Long (Eds.), *Handbook of second language acquisition* (pp. 539–588). Malden, MA: Blackwell.

Keating, G. D., Van Patten, B., & Jegerski, J. (2011). Who was walking on the beach? Anaphora resolution in Spanish heritage speakers and adult second language learners. *Studies in Second Language Acquisition, 33*, 193 – 221. doi:10.1017/S0272263110000732

Kemp, C. Defining multilingualism. In L. Aronin, & B. Hufeisen, B (Eds.), *The exploration of multilingualism* (pp. 11-26). Philadelphia, PA: John Benjamins B.V.

Kraybill, M. L., & Suchy, Y. (2008). Evaluating the role of motor regulation in figural fluency: Partialing variance in the Ruff Figural Fluency Test. *Journal of Clinical and Experimental Neuropsychology , 30* (8), 903 – 912.

Kroll, J. F., Bobb, S. C., Misra, M., & Guo, T. (2008). Language selection in bilingual speech: Evidence for inhibitory processes. *ActaPsychologica, 128,* 416-430.

Kukull, W. A., & Ganguli, M. (2012). Generalizability: The trees, the forest, and the low-hanging fruit. *Neurology, 78,* 1886–1891.

Lee, A. S., & Baskerville, R. L. (2003). Generalizing generalizability. *Information Systems Research, 14*(3), 221–243.

Lehto, J. E., Juujärvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology, 21*, 59–80.

Lewis, M. P., Simons, G. F., & Fennig, C. D. (Eds.). (2015). *Ethnologue: Languages of the World* (18^{TH} ed.). Dallas, TX: SIL International.

Lezak, M. D. (1982). The problem of assessing executive functions. *International Journal of Psychology*, 17, 281-297.

Lezak, M. D. (1995). *Neuropsychological Assessment* (3rd ed.). New York, NY: Oxford University Press.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment*. New York: Oxford University Press.

Lichtman, M. (2013). *Qualitative research in education: a user's guide*. London, United Kingdom: Sage Publications.

Longnecker, M., & Lyman Ott, R. (2010). *An introduction to statistical methods and data analysis.* Belmont, CA: Brooks/Cole, Cengage Learning.

Loonstra, A. S., Tarlow, A. R., & Sellers, A. H. (2001). COWAT metanorms across age, education, and gender. Applied Neuropsychology, 8(3), 161-166.

Lloyd, T. Q. (2010). *Delis-Kaplan Executive Function System Performance as Measure of Executive Dysfunction in Adult ADHD* (Doctoral dissertation). Brigham Young University, Provo, United States of America.

MacLeod, C. M. (2007). The concept of inhibition in cognition. In D. S. Gorfein & C. M. MacLeod (Eds.), *Inhibition in cognition* (pp. 3-23), Washington, DC: American Psychological Association.

Marian, V., Spivey, M., & Hirsch, J. (2003). Shared and separate systems in bilingual language processing: Converging evidence from eyetracking and brain imaging. *Brain and Language, 86*, 70–82.

Maria, V., Blumenfeld, H. K., & Kaushanskaya, M. (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech, Language, and Hearing Research, 50,* 940–967.

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice, 13*, 522-525.

Matute, E., Rosselli, M., Ardila, A., & Morales, G. (2004). Verbal and nonverbal fluency in Spanish-speaking children. *Developmental Neuropsychology, 26*(2), 647–660.

May, C. P., & Hasher, L. (1998). Synchrony effects in inhibitory control over thought and action. *Journal of Experimental Psychology: Human Perception and Performance, 24*, 363-379.

Mechelli, A., Crinion, J. T., Noppeney, U., O'Doherty, J., Ashburner, J., Frackowiak, R. S., & Price, C. J. (2004). Neurolinguistics: Structural plasticity in the bilingual brain. *Nature, 431*, 757.

Meuter, R. F. I., & Allport, A. (1999). Bilingual language switching in naming: Asymmetrical costs of language selection. *Journal of Memory and Language, 40,* 25–40.

Michael, E.B., & Gollan, T.H. (2005). Being and becoming bilingual: Individual differences and consequences for language production. In J.F. Kroll & A.M.B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 389–407). New York, NY: Oxford University Press.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex 'Frontal Lobe' tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49–100.

Moore, A., & Malinowski, P. (2009). Meditation, mindfulness and cognitive flexibility. *Consciousness and Cognition, 18,* 176–186.

Mueller Gathercole, V.C., Thomas, E. M., Jones, L., Guasch, N. V., Young, N., & Hughes, E. K. (2010). Cognitive effects of bilingualism: Digging deeper for the contributions of language dominance, linguistic knowledge, socio-economic status and cognitive abilities. *International Journal of Bilingual Education and Bilingualism*, *13*(5), 617-664. DOI: 10.1080/13670050.2010.488289

Nasreddine, Z. (2016). Montreal Cognitive Assessment. Retrieved from http://www.mocatest.org/about/

Nasreddine, Z. S., Phillips, N. A., Bedirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J. L., and Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. *J.Am.Geriatr.Soc, 53*(4), 695-99.

Nel, N., & Müller, H. (2010). The impact of teachers' limited English proficiency on English second language learners in South African schools. *South African Journal of Education, 30,* 635-650.

Novick, J. M., Trueswell, J. C., & Thompson-Schill, S. L. (2005). Cognitive control and parsing: Reexamining the role of Broca's area in sentence comprehension. *Cognitive, Affective, & Behavioral Neuroscience, 5*(3), 263-281.

Osborne, J. W., & Waters, E. (2002). Four assumptions of multiple regression that researchers should always test. *Practical Assessment, Research & Evaluation, 8*(2). Retrieved from http://pareonline.net/getvn.asp?v=8&n=2

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive functioning deficits in high functioning autistic individuals: Relationship to theory of mind. *Journal of child psychology and psychiatry, 32*(7), 1081-1105.

Paulhus, D. L., & Vazire, S. (2007). Handbook of Research Methods in Personality Psychology. In R.W. Robins, R.C. Fraley, & R. F. Krueger (Eds.), *Handbook of research methods in personality psychology* (pp.224-239). New York, NY: Guilford.

Peal, E., & Lambert, W. (1962). The relation of bilingualism to intelligence. *Psychological Monographs, 76*, 1–23.

Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry, 37,* 51–87.

Poarch, G. J., & van Hell, J. G. (2012). Executive functions and inhibitory control in multilingual children: Evidence from second-language learners, bilinguals, and trilinguals. *Journal of Experimental Child Psychology, 113,* 535–551.

Portocarrero, J. S., Burright, R. G. & Donovick, P. J. (2007). Vocabulary and verbal fluency of bilingual and monolingual college students. *Archives of Clinical Neuropsychology, 22,* 415–422.

PsychCorp. (2001). *Delis Kaplan Executive Function System*. USA: Pearson.

Rabbitt, P. (Ed.). (1997). *Methodology of frontal and executive function*. UK: Taylor and Francis.

Robbins, R. N., Joska, J. A., Thomas, K. G. F., Stein, D. J., Linda, T., Mellins, C. A., & Remien, R. H. (2013). Exploring the utility of the Montreal Cognitive Assessment to detect HIV-associated neurocognitive disorder: The challenge and need for culturally valid screening tests in South Africa. *Clinical Neuropsychology, 27*(3), 437–454.

Robinson, H., Calamia, M., Gläscher, J., Bruss, J., & Tranel, D. (2014). Neuroanatomical correlates of executive functions: A neuropsychological approach using the EXAMINER battery. *Journal of the International Neuropsychological Society, 20*(1), 52–63.

Ross, T. P. (2001). The reliability of cluster and switch scores for the Controlled Oral Word Association Test. *Archives of Clinical Neuropsychology, 18*, 153–164.

Ross, T. P., Calhoun, E., Cox, T., Wenner, C., Kono, W., & Pleasant, M. (2007). The reliability and validity of qualitative scores for the Controlled Oral Word Association Test. *Archives of Clinical Neuropsychology, 22*, 475–488.

Royall, D. R., Mulroy, A. R., Chiodo, L. K., & Polk, M. J. (1999). Clock Drawing is sensitive to executive control: A comparison of six methods. *Journal of Gerontology: Psychological Sciences*, *54*(5), 328-333.

Ruff, R. M., Evans, R., & Marshall, L. F. (1986). Impaired verbal and figural fluency after head injury. *Archives of clinical neuropsychology, 1*, 87-101.

Ruff, R. M., Light, R. H., Parker, S. B., & Levin, H. S. (1996). Benton controlled oral word association test: Reliability and updated norms. *Archives of Clinical Neuropsychology*, *11*(4), 329-338. doi: 10.1093/arclin/11.4.329

Salthouse, T.A. (2003). Interrelations of aging, knowledge, and cognitive performance. In U. Staudinger & U. Lindenberger (Eds), *Understanding Human Development: Dialogues with Lifespan Psychology* (pp. 265–287). New York, NY: Kluwer Academic Publishers.

Shuttleworth-Jordan, A. B. (1996). On not reinventing the wheel: A clinical perspective on culturally relevant test usage in South Africa. *South African Journal of Psychology, 26*(2), 96 -102.

Shuttleworth-Edwards, A. B. (2012). Guidelines for the use of the WAIS-IV with WAIS-III cross-cultural normative indications. *South African Journal of Psychology, Special Issue on Cognitive Science and Neuropsychology in Sothern Africa*, *42*(3), 399 -410.

Smith, D. (2003). Five principals for research ethics: cover your bases with these ethical strategies. Monitor on Psychology, 34(1), 56 – 58. Retrieved from http://www.apa.org/monitor/jan03/principles.aspx

Smith, S. R., Servesco, A. M., Edwards, J. W., Rahban, R., Barazani, S., Nowinski, L. A., Little, J. A., Blazer, A. L., & Green, J. G. (2008). Exploring the validity of the comprehensive Trail Making Test. *The Clinical Neuropsychologist*, *22*(3), 507-518.

Statistics South Africa. (2012). *Census 2011: Census in brief.* Pretoria, South Africa: Statistics South Africa.

Strauss, E., Sherman, E. M. S., & Spreen, O. (2006). *A compendium of Neuropsychological tests: Administration, norms, and commentary* (3rd ed.). New York, NY: Oxford University Press.

Suchy, Y., Kraybill, M. L., & Larson, J. C. (2010). Understanding design fluency: Motor and executive contributions. *Journal of the International Neuropsychological Society*, *16*, 26–37. doi:10.1017/S1355617709990804

Swanson, J. (2005). The Delis-Kaplan Executive Function System. *Canadian Journal of School Psychology, 20*(1).

Toglia, J. P. (2011). The dynamic interactional model of cognition in cognitive rehabilitation. In N. Katz (Ed.), *Cognition, occupation and participation across the life span: Neuroscience, neurorehabilitation and models of intervention in occupational therapy* (3rd ed., pp. 161–201). Bethesda, MD: AOTA Press.

Vaid, J. (1983). Bilingualism and brain lateralization. *Language functions and brain organization. 22*(9), 315 – 339.

Vally, Z. (2011). HIV-associated neurocognative disorders. *The South African Journal of Psychiatry, 17*(4), 98 -105. doi:10.7196/sajp.294

Van der Elst, W., Van Boxtel, M. P. J., Van Breukelen, G. J. P., & Jolles, J. ( ). The Stroop Color-Word Test Influence of age, sex, and education; and normative data for a large sample across the adult age range. *Assessment*, *13*(1), 62-79. doi: 10.1177/10731911052834

Van Wyk, E. B. (1995). Linguistic assumptions and lexicographical traditions in the African languages. *Lexikos, 5,* 82-96.

Vega-Mendoza, M., West, H., Sorace, A., & Bak, T. H. (2015). The impact of late, non-balanced bilingualism on cognitive performance. *Cognition*, *137*, 40–46.

Welsh, M. C., & Pennington, B.F. (1988). Assessing frontal lobe functioning in children: Views from developmental psychology. *Developmental Neuropsychology*, *4*(3), 199-230.

Welsh, M. C., Pennington, B. F., & Groisser, D. B. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology, 7*, 131–149.

Zied, K. M., Phillipe, A., Karine, P., Valerie, H. T., Ghislaine, A., Arnaud, R., & Didier, L. G. (2004). Bilingualism and adult differences in inhibitory mechanisms: Evidence from a bilingual stroop task. *Brain and Cognition, 54*, 254–256.

14. Appendices

Appendix A: Demographic Questionnaire

Demographic Questionnaire

Participant Code: ______________________________

Age: ______________________________

Gender: ______________________________

Highest level of education: ______________________________

Occupation: ______________________________

Home Language: ______________________________

Area of residence: ______________________________

Medical history: ______________________________

Pharmaceuticals use: ______________________________

Drug/Alcohol use: ______________________________

Years of Instruction	Public/Private Educated	Rural/Urban Location	Language of Instruction

Appendix B: Participant Information Sheet

Psychology
School of Human & Community Development

Private Bag 3, Wits 2050, South Africa. Telephone: +27 11-717-4500/2/3/4. Fax: +27-11-717-4559

Participant Information Sheet

Introduction

Good day. My name is …………………………………….. and I am a student at the School of Human and Community Development, at the University of the Witwatersrand. For the purpose of my studies, I am required to undertake research. I would like to invite you to participate in my research entitled: *"Language experience of Multilinguals and its relation to Executive functioning*."

You have been contacted by me or by other members of the research team because you are a healthy adult that holds at least a matric certificate.

Purpose and significance of the research

The purpose of this research is to explore the relationship between language experience and executive functioning in the South African Multilingual language context. Language experience is the way in which you rate yourself as being able to function in different languages. Whereas executive function can be explained as the way in which you mind manages different processes as they are happening in the brain. This will take into consideration the demographic variables of the participant's education history, as well as how they perceive their language experience. The influence of these factors on executive functioning will be examined using the results generated from a set of neuropsychological assessments. The components of executive functioning that will be looked at are; fluency, inhibition, cognitive flexibility and planning. I believe a study of this kind in the South African environment would create valuable insights into the field of cognitive functioning and multilingualism. The education system in particular could be positively influenced by added insight into language of instruction and in how to navigate multilingualism.

Procedure

If you agree to participate, you will be invited to take part in a set of neuropsychological tests that consists of different types of activities which include amongst others; answering questions, doing drawings, remembering information and solving different types of problems. These tools are frequently used by psychologists all over the world when conducting psychological assessments. The assessment will include a brief demographic questionnaire. This process will take roughly one hour. The testing will take place at a time and place of your convenience.

Research agreement

You will not receive any compensation, monetary or otherwise, for participating in the study. There will be no other benefits to participation in this research. No risks to participation in this study are anticipated. However, the cognitive testing might elicit some discomfort or irritation if some tasks are perceived as difficult, however, I would therefore like to stress that your participation in this research is entirely voluntary and you may withdraw from it at any point. You may also refrain from answering any particular question with no negative consequences. If you experience any distress associated with the assessment process, you can also ask for a pause before we continue.

Your identity as a participant will be only known to me, the researcher and my supervisor. The test protocols will be stored in a locked file cabinet and the results stored in a password protected computer. Only my supervisor and I will have access to these files. To protect confidentiality, your name or other personal identification data will not be used. Instead, an identification number will be used in each protocol.

Prior to participating in the study it is required that you completed the attached consent form. This will be kept separately from the rest of the data for the purpose of confidentiality. The consent form will be made available to the university authorities should a random audit process require this.

The M.A. research reports resulting from this research will be available in the library of the University of the Witwatersrand, which offers access to material on the world-wide web. A condensed report findings document will also be drafted and made available to you after the final research report has been completed. The findings will potentially be published in scientific journals. If you wish to have access to the results, you may request so by contacting me. The results are expected to be ready in 2016.

Enquiries

Should any matters require further clarification please do not hesitate to call or email me at:

Maritza Lubbe
Cell: 082 8133 134
Email: marz.lubbe@gmail.com

You may also contact my research supervisor, Ms Aline Ferreira-Correia, telephonically at 011 717 4527 or via email at Aline.FerreiraCorrei@wits.ac.za.

Appendix C: Informed Consent Form

Psychology
School of Human & Community Development

Private Bag 3, Wits 2050, South Africa. Telephone: +27 11-717-4500/2/3/4. Fax: +27-11-717-4559

Informed Consent Form

I am an adult person above the age of 18 years and I confirm that I have read and understand the information provided in the information sheet in relation to the research entitled: *"Language experience of South African Multilinguals and its relation to Cognitive functioning*." I have been informed about what the research entails and what is required from me. I also understand that:

- My participation is completely voluntary.
- I may withdraw from the research at any time with no negative consequences for me.
- My results and identity will be kept anonymous and the information will be kept in a password secure file, in a password secured computer and the protocols of the tests will be kept in a locked cabinet, both only accessible to the researchers and the supervisor.
- My participation will be treated with confidentiality.
- No rewards will be offered or provided for my participation.
- No risks are associated with participation, however I have been given a number for free counseling services if I experience any distress as a result of the cognitive assessment.
- I have received contact details of the researchers (Maritza Lubbe) and the supervisor (Aline Ferreira-Correia).

Participant's name: ______________________________

Participant's signature: ______________________________

Researcher's name: ______________________________

Researcher's signature: ______________________________

Date: ______________________________

Appendix D: Measure Description

1. Wechsler Adult Intelligence Scale IV (WAIS-IV) Letter-Number Sequence Subtest

The Letter-Number Sequence Subtest involves seven sets of random combinations of numbers and letters. Each set is divided into three trials, each with a different combination. The examinee is required to recall the numbers in ascending order and the letters in alphabetical order. Scoring highly on this test indicates a good working memory.The reliability score of this test is considered to be outstanding. The range of internal consistency reliability for the letter-number sequencing is between 0.85 and 0.91 and the range of test-retest reliability is between 0.70 and 0.81 (Sattler & Ryan, 2009, p.38). No psychometric information is available for this as yet for the South African context.

2. Rey Auditory Verbal Learning Test (RAVLT)

The Rey Auditory Verbal Learning Test (RAVLT) is used to assess verbal learning and memory, including immediate memory span, new learning, susceptibility to interference and recognition memory. The test consists of two word lists (List A and List B), five trials, a delayed trial and a recognition trial. Participants are given a list (List A) of 15 unrelated words repeated over five trials which they need to repeat. The participants are then given another list (List B) consisting of 15 words, the participants would then be required to repeat the original list of words and again after a delay period. The reported reliability for the RAVLT varied from 0.70 for List A and 0.38. The test-retest reliability for one year interval between test administration is reportedly moderate at 0.55 (Snow, 1988).

3. Wechsler Memory Scale- IV (WMS-IV) Visual Reproduction Subtest I and II

The Visual Reproduction Test is used to measure memory. It involves having the examinee memorizing and reproducing a number of drawings which the examiner shows them in ten seconds. The coefficient of the internal consistency among the variables-Cronbach’s alpha coefficient is reported to exceed 0.70 for the tasks of immediate and delayed recall, indicating a high internal consistency (Pasquali, 2004).

Reference List

Pasquali, L. (2004). *Psicometria: teoria dos testes napsicolgia e naeducacao*, 2nd ed. Vozes, Petropolis.

Sattler, J.M., & Ryan, J.J. (2009).*Assessment with the WAIS-IV*. Jerome M. Sattler, Publisher, Inc.

Snow, W.G., Tierney, M.C., Zorrzitto, M.L., Fisher, R.H., & Reid, D.W. (1988).One year test-retest reliability of selected tests in older adults. *Journal of Clinical and Experimental Neuropsychology, 10*, 60.

Appendix E: Additional Descriptive Statistics

Table 9.3

Descriptive Statistics for Language Experience features

Language Experience	N = 30	Minimum	Maximum	Mean	Std. Deviation
Number of languages of instruction	30	1	3	1.33	.547
Time exposed to Lang 1	30	5	85	46.43	18.49
Time exposed to Lang 2	30	2	60	25.07	10.83
Time exposed to Lang 3	30	2	60	14.40	12.85
Exp Lang 5 or more % of time	30	0	16	3.67	5.71
Chose to Read Lang1 % of time	30	0	100	73.50	24.95
Chose to Read Lang2 % of time	30	0	40	12.30	12.37
Chose to Read Lang3 % of time	30	0	100	8.80	19.03
Chose to Read Lang4 % of time	30	0	45	4.97	9.43
Chose to Read Lang5 % of time	30	0	15	1.10	3.52

Appendix F: Residual Statistics

The following four tables represent the residual statistics for the four neuropsychological scales and their components. These residual statistics are made up of the minimum, maximum, mean, standard deviation and sample size for Centered Leverage Value, Cook's Distance, Studentized Residual and Standardized Predicted Value. These statistics were utilised to allow for the investigation of outliers and influential points.

Table 9.16

Residual Statistics for MoCA subset scales

Scale	N	Minimum	Maximum	Mean	Std. Deviation
Trail making					
Std. Residual	30	-2.302	1.456	.000	.643
Stud. Residual	29	-3.464	2.651	.030	1.016
Cook's Distance	29	.000	.903	.088	.220
Centered Leverage Value	30	.269	.967	.567	.190
Clock drawing					
Std. Residual	30	-1.144	1.138	.000	.643
Stud. Residual	29	-1.924	2.259	.037	1.052
Cook's Distance	29	.000	.833	.132	.220
Centered Leverage Value	30	.269	.967	.567	.190

Table 9.17

Residual Statistics for COWAT scale

Scale	N	Minimum	Maximum	Mean	Std. Deviation
FAS Total					
Std. Residual	30	-1.969	1.398	.000	.643
Stud. Residual	29	-2.759	1.982	-.009	.988
Cook's Distance	29	.000	.898	.125	.218
Centered Leverage Value	30	.269	.967	.567	.190
FAS Total Errors					
Std. Residual	30	-1.121	2.393	.000	.643
Stud. Residual	29	-1.678	3.393	.030	1.008
Cook's Distance	29	.000	1.902	.149	.366
Centered Leverage Value	30	.269	.967	.567	.190

Table 9.18

Residual Statistics for SWCIT scale

Scale	N	Minimum	Maximum	Mean	Std. Deviation
Word					
Std. Residual	30	-1.678	1.349	.000	.643
Stud. Residual	29	-2.302	2.174	-.042	1.017
Cook's Distance	29	.000	1.643	.152	.328
Centered Leverage Value	30	.269	.967	.567	.190
Colour					
Std. Residual	30	-1.517	1.617	.000	.643
Stud. Residual	29	-2.151	2.196	-.078	1.053
Cook's Distance	29	.000	5.686	.283	1.044
Centered Leverage Value	30	.269	.967	.567	.190
Word-Colour					
Std. Residual	30	-1.154	2.053	.000	.643
Stud. Residual	29	-1.584	2.911	.001	1.002
Cook's Distance	29	.000	.998	.129	.223
Centered Leverage Value	30	.269	.967	.567	.190

Table 9.19

Residual Statistics for D-KEFS: Design Fluency scale

Scale	N	Minimum	Maximum	Mean	Std. Deviation
Condition 1					
Std. Residual	30	-1.633	1.775	.000	.643
Stud. Residual	29	-2.630	2.351	-.004	1.029
Cook's Distance	29	.000	.613	.110	.181
Centered Leverage Value	30	.269	.967	.567	.190
Condition 1 Total Errors					
Std. Residual	30	-1.683	1.596	.000	.643
Stud. Residual	29	-2.059	2.066	.051	.946
Cook's Distance	29	.000	.977	.091	.180
Centered Leverage Value	30	.269	.967	.567	.190

(continued)

Table 9.19

Residual Statistics for D-KEFS: Design Fluency scale (continues)

Scale	N	Minimum	Maximum	Mean	Std. Deviation
Condition 2					
Std. Residual	30	-1.366	1.701	.000	.643
Stud. Residual	29	-1.747	2.203	.076	.955
Cook's Distance	29	.000	1.810	.136	.339
Centered Leverage Value	30	.269	.967	.567	.190
Condition 2 Total Errors					
Std. Residual	30	-1.409	1.129	.000	.643
Stud. Residual	29	-1.913	1.818	-.010	.993
Cook's Distance	29	.000	.709	.115	.170
Centered Leverage Value	30	.269	.967	.567	.190
Condition 3					
Std. Residual	30	-1.749	1.758	.000	.643
Stud. Residual	29	-2.563	2.343	-.052	1.000
Cook's Distance	29	.000	1.072	.119	.216
Centered Leverage Value	30	.269	.967	.567	.190
Condition 3 Total Errors					
Std. Residual	30	-1.225	1.817	.000	.643
Stud. Residual	29	-1.957	2.662	.058	1.079
Cook's Distance	29	.000	2.671	.183	.503
Centered Leverage Value	30	.269	.967	.567	.190
Total Set Loss					
Std. Residual	30	-.938	1.718	.000	.643
Stud. Residual	29	-1.754	2.516	.022	1.094
Cook's Distance	29	.000	2.751	.194	.529
Centered Leverage Value	30	.269	.967	.567	.190
Total Repetition					
Std. Residual	30	-1.200	1.548	.000	.643
Stud. Residual	29	-1.469	2.063	.036	.942
Cook's Distance	29	.000	.412	.076	.103
Centered Leverage Value	30	.269	.967	.567	.190
Design Accuracy					
Std. Residual	30	-1.276	1.606	.000	.643
Stud. Residual	29	-2.795	1.966	-.038	1.124
Cook's Distance	29	.000	4.082	.254	.762
Centered Leverage Value	30	.269	.967	.567	.190